Quantitative Pupillometry Obtained During Cardiac Arrest: A Case Report

Kathrina Siaron, BSN, RN, CCRN, SCRN
Lilian Otieno, BSN, RN
Lindsay M. Riskey, BA, BSN, RN, SCRN
Sharla Houston, BSN, RN
DaiWai M. Olson, PhD, RN
Emerson B. Nairon, BSA

Introduction Quantitative pupillometry is increasingly used to assess patients' neurologic function quickly and accurately. This case report discusses the feasibility of collecting quantitative pupillometry data for patients experiencing cardiac arrest, the potential value of these data, and limitations of quantitative pupillometry.

Clinical Findings An 83-year-old woman was admitted to the cardiac catheterization laboratory for coronary angiography and percutaneous coronary intervention. She experienced cardiac arrest during the procedure, and the rapid response team was deployed.

Diagnosis Coronary artery disease with angina was present upon admission. The patient was admitted with the intent to perform percutaneous coronary intervention of the left anterior descending coronary artery.

Interventions During the cardiac arrest and while staff members were performing chest compressions, rapid response team nurses obtained quantitative pupillometry readings to assess pupil function.

Outcomes The quantitative pupillometry readings obtained from the left and right eyes suggested that neurologic function was abnormal but still present. The main challenges associated with performing quantitative pupillometry during a cardiac arrest are overcrowding of essential personnel at the head of bed and finding an appropriate time to obtain readings without compromising life-sustaining interventions.

Conclusion Using quantitative pupillometry to assess pupil function during cardiac arrest is feasible when performed by nurses. This report may facilitate pupil assessment during cardiac arrest and provide new insights into cerebral perfusion as a biomarker of recovery. (*Critical Care Nurse*. 2026;46[3]:11-15)

CE 1.0 hour, CERP A

This article has been designated for CE contact hour(s). The evaluation tests your knowledge of the following objectives:

1. Discuss the value of identifying a biomarker of cerebral perfusion during cardiopulmonary resuscitation.
2. Identify the advantages of using quantitative pupillometry to evaluate neurological status in a patient with acquired brain injury.
3. List the steps necessary to measure the pupillary light reflex during cardiopulmonary resuscitation.

When completing this activity, you will need to identify 3 concepts you have learned by reading this article.

To see CE activity C2661, visit https://aacnjournals.org/ccnonline/ce-articles. Once the article opens, click the CE Article button to complete the assessment. No CE fee for AACN members. See CE activity page for details and expiration date.

 doi:https://doi.org/10.4037/ccn2026662

Quantitative pupillometry is used widely among clinical care teams, particularly in critical care units, where it has been demonstrated to reliably provide insight about cerebral perfusion and cranial nerve function.[1-3] Assessing the pupillary light reflex indicates neurologic function through data such as minimum and maximum pupil size, latency, constriction velocity, and relative overall reactivity.[4,5] Quantitative pupillometry devices produce a summary score known as the neurological pupil index (NPi), a scalar value that ranges from 0 to 4.9 and categorizes the pupillary light reflex as normal (scores of 3.0-4.9), abnormal (scores of 0.1-2.9), or nonreactive (score of 0).[6] Although quantitative pupillometry is most commonly used in intensive care units (ICUs), recent studies have demonstrated its utility in prehospital settings, emergency departments, and multiple in-hospital and clinic settings.[7,8]

Current literature has demonstrated that quantitative pupillometry provides prognostic insight for patients who have experienced cardiac arrest. Abnormal and absent pupillary light reflexes indicate decreased brain stem function linked to inadequate cerebral perfusion during resuscitation. Maintaining adequate cardiac output preserves cerebral perfusion pressure during cardiac arrest and improves chances for optimal recovery. Monitoring the end-tidal carbon dioxide level provides information about global perfusion (via monitoring for carbon dioxide production) and is recommended during resuscitation to help identify proper placement of any adjunct airway and for use as an indirect measure of the adequacy of compressions.[9] However, a normal end-tidal carbon dioxide level does not confirm adequate cerebral perfusion. Because the pupillary light reflex is closely tied to cerebral perfusion, the use of quantitative pupillometry during resuscitation may provide much-needed insight regarding the resuscitation efforts. This case report explores the feasibility of having trained professionals obtain quantitative pupillometry data during a patient's cardiac arrest and discusses how these data may be used to inform clinical care.

Clinical Findings and Diagnosis

An 83-year-old White woman presented to a university hospital in the last quarter of 2024. The patient had a history of acute respiratory failure with hypoxemia, left anterior descending artery disease, angina, moderate aortic regurgitation, hypertension, dyslipidemia, and stage 3 chronic kidney disease. A coronary angiogram was planned with the intent to perform staged percutaneous coronary intervention in the left anterior descending and diagonal arteries and possibly treat other vessels on the basis of angiography findings. After the risks and benefits were discussed with the patient and her family, she consented to the procedure and was admitted to the cardiac catheterization laboratory. She experienced sudden cardiac arrest during the procedure and underwent emergency cannulation for venoarterial extracorporeal membrane oxygenation.

Interventions

The rapid response team was activated for cardiac arrest after 12 AM (exact time not provided to preserve anonymity). When the rapid response team arrived, the patient had already been successfully intubated and was receiving manual ventilation via a bag valve mask. Ongoing resuscitation followed the current Advanced Cardiac Life Support protocol. The interventional cardiologists continued to attempt the planned procedure. An adequate number of additional staff members was present. A registered nurse on the rapid response team was designated

Authors

Kathrina Siaron is an assistant nurse manager, Department of Nursing, University of Texas Southwestern Medical Center, Dallas, Texas.

Lilian Otieno is an assistant nurse manager, Department of Nursing, University of Texas Southwestern Medical Center.

Lindsay M. Riskey is a registered nurse II, Department of Nursing, University of Texas Southwestern Medical Center.

Sharla Houston is a registered nurse II, Department of Nursing, University of Texas Southwestern Medical Center.

DaiWai M. Olson is a professor, Department of Neurology, University of Texas Southwestern Medical Center. He is the editor of the Journal of Neuroscience Nursing.

Emerson B. Nairon is a clinical research coordinator, Department of Neurology, University of Texas Southwestern Medical Center.

Corresponding author: DaiWai M. Olson, PhD, RN, Department of Neurology, University of Texas Southwestern Medical Center, 5323 Harry Hines Blvd, CS05.106, Dallas, TX 75390-8855 (email: daiwai.olson@utsouthwestern.edu).

To purchase electronic or print reprints, contact the American Association of Critical-Care Nurses, 27071 Aliso Creek Rd, Aliso Viejo, CA 92656. Phone, (800) 899-1712 or (949) 362-2050 (ext 532); fax, (949) 362-2049; email, reprints@aacn.org.

to collect pupillometry data, and the team was made aware that quantitative pupillometry would be performed during resuscitation. The designated nurse made her way to the head of the bed, where a respiratory therapist was providing manual ventilation. The nurse made eye contact with the respiratory therapist and then explained what she intended to do; this step was important to promote optimal team collaboration. The patient's eyelids had earlier been taped shut for corneal protection. The nurse removed the tape and assessed the right pupil first because the respiratory therapist was positioned to the patient's left while providing manual ventilation. The respiratory therapist assumed a more midline position to create room for the nurse to obtain a pupillometry reading. Each pupillometry reading took about 30 seconds to obtain due to inadvertent patient head movement during continuous chest compressions. The respiratory therapist provided extra support to stabilize the patient's head, allowing the nurse to obtain the targeting circle on the quantitative pupillometry device to signal that the device had identified the patient's pupil (see Figure).

The anesthesiologist was inserting a central venous catheter and required more room to move on the right side of the patient. Securing central venous access was a top priority because the patient required multiple vasopressors and rapid infusion access, so to assess the left pupil, the nurse opted to walk around the room to the left side of the patient. The respiratory therapist once again moved to give the nurse space to perform quantitative pupillometry. Assessment of both pupils took a total of about 3 minutes, including time spent navigating around people and equipment inside the crowded cardiac catheterization laboratory.

The quantitative pupillometry results are shown in the Table. The NPi (measure of pupil reactivity) of less than 3 in both eyes represented abnormal brain function. The pupil sizes were unequal, with the right pupil being slightly larger than the left, but the difference was not clinically significant. Although none of the measured values fell within the normal healthy range, a complete assessment was achieved in both eyes. The team was notified that although the NPi values in both eyes were less than 3.0 (abnormal), the finding of preserved pupil function might indicate cerebral perfusion with cardiopulmonary resuscitation (CPR). We established the feasibility of obtaining pupil scans during CPR. Despite the presence of multiple essential personnel at the head of the patient's bed, the nurse was able to scan both eyes efficiently and provide critical insight into brain function that would have been otherwise unavailable.

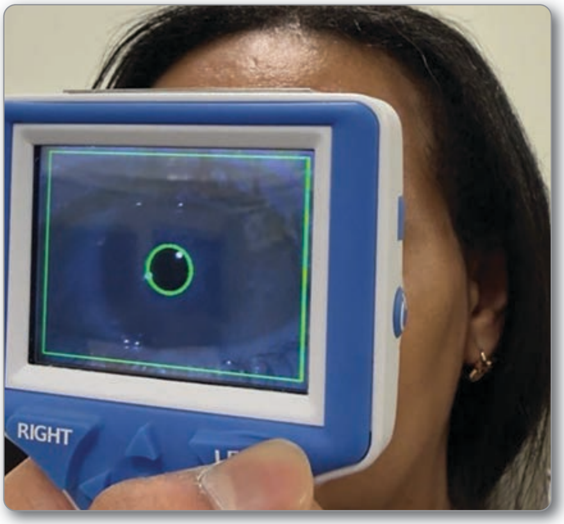

Figure Quantitative pupillometer showing the circle highlighting the pupil and indicating that a measurement can be obtained.

Table Quantitative pupillometry data from patient during cardiac arrest

Characteristic	Left eye	Right eye
Neurological pupil index	0.7	1.9
Size, pupil diameter at rest, mm	5.90	6.53
Minimum pupil size, mm	5.49	5.52
Percent constriction	7	15
Constriction velocity, mm/s	0.40	0.83
Maximum constriction velocity, mm/s	1.01	2.19
Dilation velocity, mm/s	0.42	0.47
Latency of constriction, s	0.33	0.20

Outcomes

After 60 minutes of CPR, return of spontaneous circulation was obtained. Repeated quantitative pupillometry measurements could not be obtained because the patient's condition deteriorated further. Within a few minutes the patient required the initiation of massive transfusion protocol and venoarterial extracorporeal membrane oxygenation. These interventions necessitated even more staff and equipment to be introduced to the cardiac catheterization laboratory and severely limited the nurse's ability to move around the room. After the patient underwent cannulation for venoarterial extracorporeal membrane oxygenation and was stabilized, she was transported in critically ill condition to the cardiovascular ICU.

Discussion

Acquired brain injury is a leading cause of death and disability in patients who experience cardiac arrest. Rapid response teams (high-acuity response teams) improve patient care outcomes.[10] The literature suggests that 80% of people who experience cardiac arrest will experience a postarrest comatose state due to inadequate brain oxygenation.[11] Current resuscitation standards from the American Heart Association indicate that continuous end-tidal carbon dioxide monitoring during CPR is the standard method for indirectly assessing blood flow generated by chest compressions. In a patient receiving high-quality compressions, end-tidal carbon dioxide levels should reach at least 20 mm Hg. However, end-tidal carbon dioxide is only an indirect measure of systemic perfusion and is not specific to the brain.

Brain monitoring techniques in place before arrest, such as continuous electroencephalography or intracranial pressure monitoring devices, may assist in prognostication after cardiac arrest but require prolonged monitoring time to infer useful data and are not commonly used outside the neuroscience ICU. Placement of these devices is also time-consuming and impractical at the beginning of a cardiac arrest. The use of quantitative pupillometers is evidence based, and these devices should be available to support best practice for neuromonitoring.[12,13] Quantitative pupillometry is a convenient, portable, noninvasive method of monitoring neurologic function and can provide insight within a few seconds of procedure initiation.

To acquire sequential quantitative pupillometry measurements at set intervals, a staff member may need to be designated for this role.

The utility of performing quantitative pupillometry during cardiac arrest is largely in the ability to collect data that may prevent secondary brain injury.[14] Pupil reactivity is a biomarker of brain function and is directly measured by the NPi.[15] Abnormal pupil reactivity during arrest may be an early predictor of ischemic injury. On the other hand, normal pupil function during arrest could indicate that the compressions during resuscitation are effective at achieving brain perfusion. Measuring pupil function at set intervals during CPR could provide a real-time trend to show the efficacy of resuscitative efforts and offer an opportunity for clinicians to change course if their interventions are ineffective at achieving brain perfusion. After quantitative pupillometry values are uploaded or manually documented in the medical record, they can also be correlated to other recorded vital signs, such as heart rate and end-tidal carbon dioxide measurements, to indicate return of spontaneous circulation.

Incorporating pupillometry during the CPR routine requires several logistical considerations. As shown in the case study, crowding due to concurrent procedures can become a significant obstacle in acquiring sequential quantitative pupillometry measurements. Unlike typical patient rooms where the patient's bed can be moved to clear a path to the head of the bed, catheterization laboratories tend to have the radiograph C-arm machine at the head of the patient's bed, potentially obstructing the nurse's approach. Securing the airway and providing adequate ventilation are top priorities during CPR; therefore, quantitative pupillometry may have to wait until after intubation. The clinician performing quantitative pupillometry will also need to collaborate with the respiratory therapist and other personnel to avoid interrupting ventilations.

To acquire sequential quantitative pupillometry measurements at set intervals, a staff member may need to be designated for this role. This designation effectively increases the number of staff members required in the code team. If the institution has a team tasked to respond to code activations, these team members will benefit from quantitative pupillometry training so that any member can assume the role. Training should include a competency assessment and skill validation via live demonstration of the use of a pupillometer. Finally, cardiac arrest can occur in any setting within the institution. If the location does not have a quantitative pupillometer readily available, the initiation of quantitative pupillometry will be delayed until a device can be located. Cardiopulmonary resuscitation should not be delayed for any reason and should continue in the meantime. Pupillometers are small, lightweight, handheld devices that charge while docked and can easily be stowed into an emergency bag for on-the-go use or kept on top of a code cart for convenience.

Pupillometers are now available in more than 900 hospitals in the United States and more than 40 countries, and several companies manufacture commercial handheld devices.[4] However, the availability of pupillometers within hospitals is highly varied. Our hospital has more than 100 devices. Practice settings such as units for stroke, epilepsy monitoring, and neurocritical care typically have 1 device per bed, and other practice areas (such as geriatric care units) may have only 1 or 2 devices. For institutions that have designated response teams, allocating at least 1 quantitative pupillometer to be carried by response personnel could help prompt pupillometry upon initiation of CPR. Further feasibility studies should be performed to verify the logistical practicality of this idea within different types of settings and different sizes of institutions. Where pupillometers are already established as part of the standard of care, quality improvement projects will be ideal vehicles for widening the application of existing devices. Pilot studies can be done within controlled environments (such as ICUs) where a number of patients can be expected to require CPR.

Conclusion

This case study shows that obtaining quantitative pupillometry during cardiac arrest is feasible, is cost-effective, and can be rapidly performed by many different personnel. Quantitative pupillometry data have the potential to serve as biomarkers for cerebral perfusion status in patients experiencing cardiac arrest. Challenges associated with obtaining the readings include crowding, movement during compressions, and finding an appropriate time to obtain readings. However, given that acquired brain injury is of major concern for patients who experience cardiac arrest, acquiring rapidly generated insight into brain function through quantitative pupillometry could change the way we provide care. CCN

Acknowledgments
The authors acknowledge Danielle Emmerton for her assistance and support of this project.

Financial Disclosures
None reported.

See also

To learn more about pupillometry in the critical care setting, read "Describing Anisocoria in Neurocritically Ill Patients" by Saju et al in the *American Journal of Critical Care,* 2023;32(6):402-409. https://doi.org/10.4037/ajcc2023558. Available at **www.ajcconline.org.**

References

1. Bower MM, Sweidan AJ, Xu JC, Stern-Neze S, Yu W, Groysman LI. Quantitative pupillometry in the intensive care unit. *J Intensive Care Med*. 2021;36(4):383-391. doi:10.1177/0885066619881124
2. Zhao W, Stutzman S, DaiWai O, Saju C, Wilson M, Aiyagari V. Inter-device reliability of the NPi-100 pupillometer. *J Clin Neurosci*. 2016;33:79-82. doi:10.1016/j.jocn.2016.01.039
3. Stutzman S, Iype P, Marshall J, et al. Inter-device reliability of the NPi-200 and NPi-300 pupillometers. *J Clin Neurosci*. 2022;100:180-183. doi:10.1016/j.jocn.2022.04.023
4. Figueroa SA, Olson DM, Kamal A, Aiyagari V. Quantitative pupillometry: clinical applications for the internist. *Am J Med*. 2024;137(9):825-831. doi:10.1016/j.amjmed.2024.04.043
5. Olson DM, Fishel M. The use of automated pupillometry in critical care. *Crit Care Nurs Clin North Am*. 2016;28(1):101-107. doi:10.1016/j.cnc.2015.09.003
6. Lussier BL, Stutzman SE, Atem F, et al. Distributions and reference ranges for automated pupillometer values in neurocritical care patients. *J Neurosci Nurs*. 2019;51(6):335-340.
7. Nyholm B, Grand J, Obling LER, et al. Quantitative pupillometry for neuroprognostication in comatose post-cardiac arrest patients: a protocol for a predefined sub-study of the Blood Pressure and Oxygenations Targets After Out-of-Hospital Cardiac Arrest (BOX)-trial. *Resusc Plus*. 2023;16:100475. doi:10.1016/j.resplu.2023.100475
8. Jolkovsky EL, Fernandez-Penny FE, Alexis M, Benson LN, Wang BH, Abella BS. Impact of acute intoxication on quantitative pupillometry assessment in the emergency department. *J Am Coll Emerg Physicians Open*. 2022;3(5):e12825. doi:10.1002/emp2.12825
9. Baldi E, Caputo ML, Klersy C, et al. End-tidal carbon dioxide (ETCO2) at intubation and its increase after 10 minutes resuscitation predicts survival with good neurological outcome in out-of-hospital cardiac arrest patients. *Resuscitation*. 2022;181:197-207.
10. Weigand L, Viers T, Tipton E. Integration of rapid response teams and early warning systems to reduce cardiac arrests and intensive care unit readmissions. *Crit Care Nurse*. 2025;45(4):49-56.
11. Sandroni C, Cronberg T, Sekhon M. Brain injury after cardiac arrest: pathophysiology, treatment, and prognosis. *Intensive Care Med*. 2021;47(12):1393-1414. doi:10.1007/s00134-021-06548-2
12. Cuzmenco S. Strategies to achieve evidence-based practice in nursing. *Crit Care Nurse*. 2024;44(1):10-11. doi:10.4037/ccn2024359
13. Shamoun CJ, Baby P, Bautista C, et al. Neuromonitoring in neuroscience nursing: collaboration from the 2025 International Neuroscience Nursing Symposium. *J Neurosci Nurs*. 2025;57(4):152-157. doi:10.1097/jnn.0000000000000838
14. Rana C, Moreno JH, Marshall JL, Olson DM, Aiyagari V. Neuroradiological correlates of abnormal pupillary light reflex findings among patients in the neuroscience intensive care unit. *J Neurosci Nurs*. 2025;57(2):83-87. doi:10.1097/jnn.0000000000000818
15. Carrick FR, Azzolino SF, Hunfalvay M, et al. The pupillary light reflex as a biomarker of concussion. *Life (Basel)*. 2021;11(10):1104. doi:10.3390/life11101104