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| Origination | 08/2024 | Owner | Karen McQuillan: Lead Clinical Nurse Specialist STC |
| Last Approved | 08/2024 | Area | Hospital Guidelines |
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| Last Revised | 08/2024 | | |
| Next Review | 08/2027 | | |

# Guideline for Use of Pupillometry



## I. GUIDELINE

A. **OBJECTIVES**

1. To provide guidelines for the measurement and monitoring of pupillary function of select patients using the NeurOptics® Pupillometer.

B. **BACKGROUND**

1. Pupillary size, shape, and reactivity to light are key indicators of neurologic function in brain-injured patients, especially in comatose patients. However, this exam performed by a penlight is subjective and variable between assessments and between providers. Common terms such as brisk or sluggish are used to describe pupillary reactivity and pinpoint or moderate are used to describe pupillary size.
2. Automated pupillometry provides objective quantitative measures including maximal diameter, latency, constriction velocity, minimal diameter, and dilation velocity.
    a. The NeurOptic pupillometer provides the Neurologic Pupil Index (NPi™) which incorporates all the measurements into a single parameter using a proprietary algorithm.
    b. The NPi™ has been shown to be a predictor of intracranial pressure elevations and may aid in prognostication in select patients such as those on extracorporeal membrane oxygenation following cardiac arrest.
    c. Current evidence supports automated pupillometry as a tool for accurate and consistent pupil measurement, potentially allowing for earlier recognition of subtle pupil changes and timelier diagnostic and treatment interventions.

3. Findings with Pupillometry that have been found to correlate with increases in ICP:
    a. Change in pupil size of < 10% between before and after light stimulation.
    b. CV of < 0.8 mm/s suggestive of increases in brain volume.
    c. CV of < 0.6 mm/s suggestive of ICP elevation > 20 mmHg or will be elevated within 15-30 minutes.
    d. Unequal pupils > 1 mm in size difference.
    e. NPi™ value <3 means the ICP is either >20mmHg or will elevate within 16 hours.
    f. NPi™ difference between two eyes >0.7
4. For Prognostication:
    a. ECMO: NPi <3, at any time between 24 and 72 hours of initiation has been found to be 100% specific for 90-day mortality (Miroz et al., 2020).
    b. Cardiac arrest: At any time between day 1 and 3, an NPi ≤ 2 has been shown to have a 51% (95% CI 49–53) negative predictive value and a 100% positive predictive value [PPV; 0% (0–2) false-positive rate], with a 100% (98–100) specificity and 32% (27–38) sensitivity for the prediction of unfavorable outcome (Behrends, et al, 2012).

C. **INDICATION FOR PUPILLOMETER USE**

1. Upon admission, select patients should receive a baseline pupil assessment using the NeurOptics® Pupillometer. The frequency of subsequent pupillometer measurements will be based on provider order, patient acuity, and change in patient condition. Patients considered for pupillometry assessment, include but are not limited to:
    a. Patients with potential for secondary neurologic injury
        i. Patients require a neurologic exam every 1 hour with close monitoring of pupillary assessment for concerns of neurologic deterioration. At risk for any of the following:
            a. Cerebral edema
            b. Elevation in ICP
            c. Delayed cerebral ischemia (DCI) (Aoun et al., 2020)
            d. Identification of herniation syndromes
        ii. Patients with known or suspected neurological injury (e.g., traumatic brain injury, intracerebral hemorrhage, ischemic or hemorrhagic stroke)
        iii. Patients with intracranial monitoring: ICP, brain tissue oxygen, or considered for cerebral microdialysis
        iv. Patients undergoing hyperosmolar therapy brain injury
        v. Seizure/status epilepticus (Godau et al., 2020)

b. For prognostication

i. After Cardiac Arrest (including those undergoing TTM post-arrest)

ii. When there are questionable results using a manual pupillary exam

# II. DEFINITIONS

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| Constriction velocity (CV) | The change in size divided by the time during which constriction occurs in response to light (Olson et al., 2017)<br>Average of how fast the pupil diameter is constricting measured in millimeters per second |
| Dilation Velocity (DV) | The average pupillary velocity when, after having reached the peak of constriction, the pupil tends to recover and to dilate back to the initial resting size, measured in millimeters per second |
| ECMO | Extracorporeal membrane oxygenation |
| EHR | Electronic Health Record |
| GCS | Glasgow Coma Score/Scale |
| ICP | Intracranial pressure |
| Latency of Constriction (LAT) | The period from initial light stimulus to the start of pupillary constriction (Olson et al., 2017).<br>Time of onset of constriction following initiation of the light stimulus |
| Maximum Constriction Velocity (MCV) | Maximum velocity of pupil constriction of the pupil diameter responding to the flash of light measured in millimeters per second |
| Neurologic Pupil Index (NPi™) (NeurOptics, 2022) | A derived value, calculated by the pupillometer, that compares the reading obtained against normative models (Olson et al., 2017).<br>Normal range (3.0 to 4.9 or “brisk”)<br>Abnormal range (< 3.0 [0.1 – 2.9] or “sluggish”)<br>“Atypical,” “immeasurable,” or “non-reactive” (0) |
| Percent change of pupil (CON or %CH or % Change) | % of change (Size-MIN) / Size as a % |
| Pupillary size after a light stimulus (MIN) | Pupil diameter at peak constriction |
| Pupillary size prior to the light stimulation (MAX or Size) | Maximum pupil size before constriction |
| ROSC | Return of Spontaneous Circulation |
| TTM | Targeted Temperature Management |

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| TBI | Traumatic Brain Injury |

# III. RESPONSIBILITY

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| Provider | Prescribe desired frequency of pupil assessment using the pupillometer. General guidelines:<br>• Every 1-hour and PRN – Patients at risk for neurologic decline; More frequent assessments may be indicated in patients with unstable neurologic status.<br>• Consider every 2 hours – Patient follows commands; stable neuropathology > 24 hours; Risk for delirium risk due to sleep disruption > benefit of pupil assessment.<br>• Consider every 4 hours – Stable neurologic exam; no risk for neurologic decline |
| Nurse | Assess pupils with the pupillometer at prescribed intervals and more frequently during episodes of neurological deterioration (e.g., herniation events<br>Document pupil assessment findings on the pupillometer display at the prescribed interval in the EHR, including<br>• Pupil size and equality<br>• Pupil reactivity as defined by the NPi<br>Perform a neurologic exam if change detected in pupillometry measurement.<br>Notify the provider when significant pupil findings or changes in pupil assessment are found, including<br>**NOTE**: A downward trend of the NPi may be an indication of impending neurologic deterioration<br>• NPi < 3.0 (change from baseline)<br>• Difference in pupil sizes from right to left > 1mm (change from baseline)<br>• Difference in NPi between right and left of greater than 0.7 |



# IV. GUIDELINE

A. **EQUIPMENT/SUPPLIES**

1. Charging station
2. NPi®-200 Pupillometer
3. Single patient use SmartGuard®
4. Patient identification label

B. **GUIDELINE**

1. Obtain NPi®-200 Pupillometer from the charging station.
    a. Green Light on charging station: indicates the device is fully charged

b. Blue Light on charging station: indicates the device is actively charging

c. To turn the device on

i. When removed from the Charging Station, the device it will wake up automatically

ii. If device is in sleep mode, tap the screen, place on the charging station, or press the up arrow/On button to turn it back on

iii. If the device had been out of the Charging Station for more than 20 minutes and has powered down, press the On/Off button on the right side of the device to turn it on.

2. Obtain disposable SmartGuard® and place it on the Pupillometer.

a. Ensure the SmartGuard® is labeled with a patient identification label and kept in the patient's room for reuse for the duration of the patient admission or until the memory chip is full (168 readings).

3. For first-time use, select either "Manual ID" (keypad touch entry) or "Scan Code" (incorporated wristband barcode scanner) to enter patient medical record number (MRN). If the patient MRN has already been entered, verify the MRN displayed and select Accept.

a. NOTE: For patients who are a Trauma Doe, utilize the initial trauma MRN.

b. Once the patient has been identified, write the patient's name on the trauma identification label of the SmartGuard® to maintain the history within the microchip.

4. Select right or left eye to be scanned and position the Pupillometer in front of this eye.

a. The SmartGuard should be positioned with the foam pad at the patient's cheekbone below the eye with the Pupillometer at a right angle to the patient's axis of vision, minimizing any tilting of the device.

b. Hold open the eyelid or ask patient to hold the eyelid in the open position.

5. Press and hold the corresponding RIGHT or LEFT button

a. Reposition the Pupillometer as needed (avoid tilting the device) until the pupil is centered on the screen and encircled by a green ring, indicating the pupil is targeted.

b. A red frame around the screen indicates the pupil needs to be re-centered on the screen before the measurement is initiated.

6. Once the green ring appears, release the button and hold the Pupillometer in place for approximately three seconds until results are analyzed and displayed on the screen.

7. Repeat the scan procedure for the patient's other eye to complete the bilateral pupil exam.

8. If the result shows in red and reads "Rescan", there was an error with the reading.

Repeat the measurement for this eye.

9. View Results
    a. When the bilateral pupil exam is complete, the measurement results will be displayed in green for the RIGHT eye and yellow for the LEFT eye.
    b. The difference between right and left eye values will also be shown in the third column.
    c. Additional measurements are found on “Results page 2”.
10. Document required values
    a. Size and NPi® are found on results screen 1/2 on the Pupillometer.
11. Remove SmartGuard® and leave at the patient’s bedside.
12. Disinfect the Pupillometer and place it back into the charging station for recharging.
    a. Isopropyl alcohol (IPA)-based cleaning solutions, in formula concentrations up to 70% IPA, are recommended for use in cleaning the NPi-300.
    b. To avoid corrosion, ensure the charging prongs are dry prior to placing back on charging station.
    c. Be sure to allow appropriate disinfectant dwell time prior to use on another patient.
    d. If using a bleach-based solution or wipe, allow appropriate dwell time and remove residue using a non-bleach wipe.
13. Dispose of the SmartGuard® in a red biohazard waste receptacle, due to the presence of protected health information within the microchip, when patient monitoring is complete.

C. **NOTE:** This Guideline was developed with input from the NCCU Clinical Practice Council Guidelines

# V. REPORTABLE CONDITIONS

A. Nurse should notify the provider when significant pupil findings or changes in pupil assessment are found, including
    1. NPi < 3.0 (change from baseline)
    2. Difference in pupil sizes from right to left > 1mm (change from baseline)
    3. Difference in NPi between right and left of greater than 0.7
    4. **NOTE**: A downward trend of the NPi may be an indication of impending neurologic deterioration

# VI. DOCUMENTATION

A. Provider should prescribe desired frequency of pupil assessment using the pupillometer.

B. Nurse should document pupil assessment findings on the pupillometer display at the prescribed interval in the EHR, including

1. Pupil size and equality
2. Pupil reactivity as defined by the NPi

# VII. SUPPORTIVE INFORMATION

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B. **COMMUNICATION AND EDUCATION**

1. This guideline will be communicated to the appropriate UMMC personnel via the following channels:
    a. The guideline will be placed within PolicyStat on the intranet.
    b. Re-education and revisions will be communicated via Medical Staff , Patient Care Service, and
    Nursing meetings and publications as needed.

*References reviewed 6/14/24.*

## Approval Signatures

| Step Description | Approver | Date |
|---|---|---|
| Clinical Practice Council | Scott Taylor: Clinical Practice & Development Coordinator | 08/2024 |
| Policy Oversight Committee | Baylee Chambers: Project Manager CCO Office | 07/2024 |
| Critical Care Ops | Karen McQuillan: Lead Clin Nurse Spec Stc | 06/2024 |

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| Karen McQuillan: Lead Clin Nurse Spec Stc | 06/2024 |

## Applicability

UMMC Downtown Campus