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La rilevazione della pupillometria automatica nell'ambito della Terapia Intensiva Pediatrica

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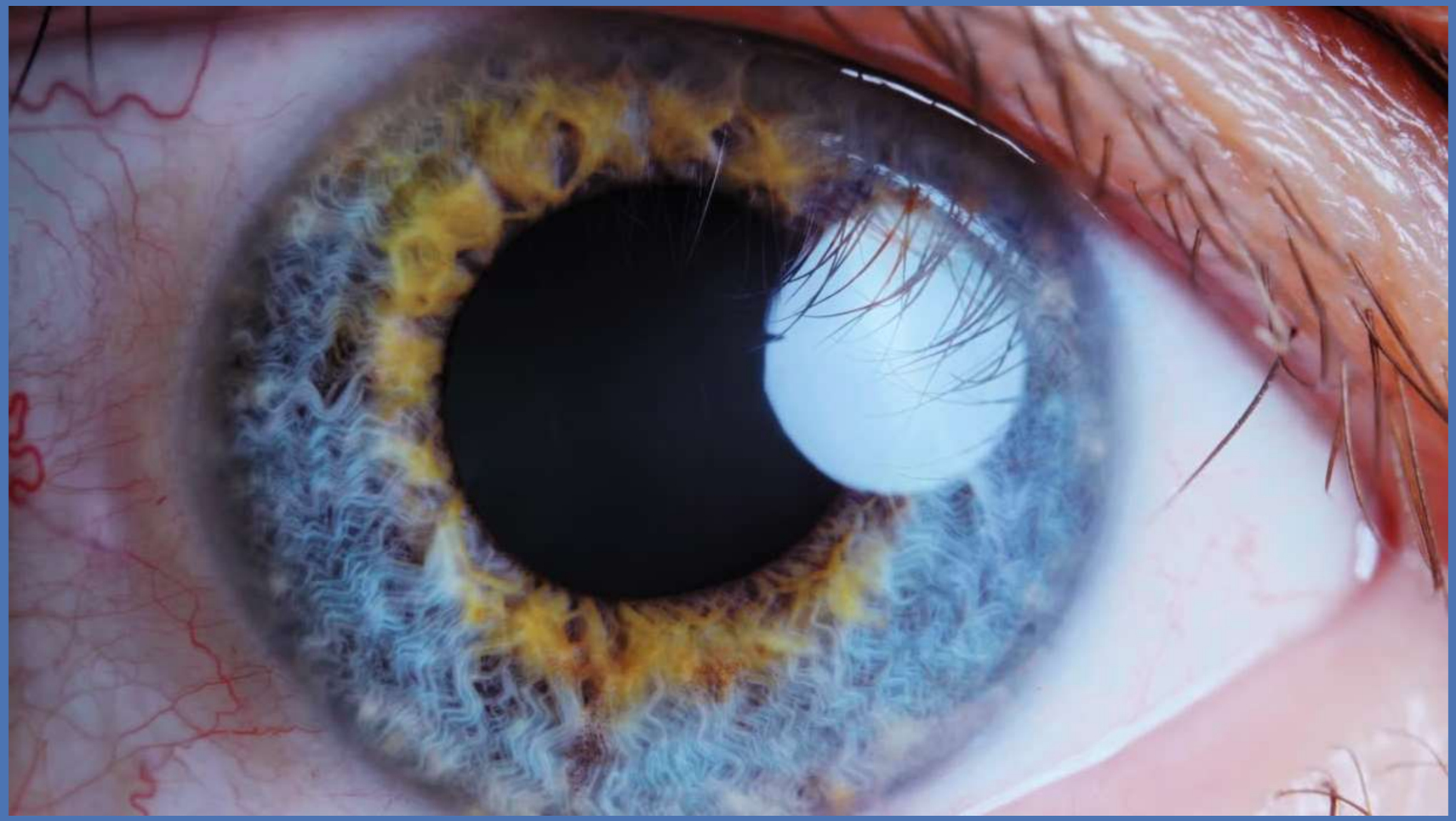
ASST Spedali Civili di Brescia

Indice



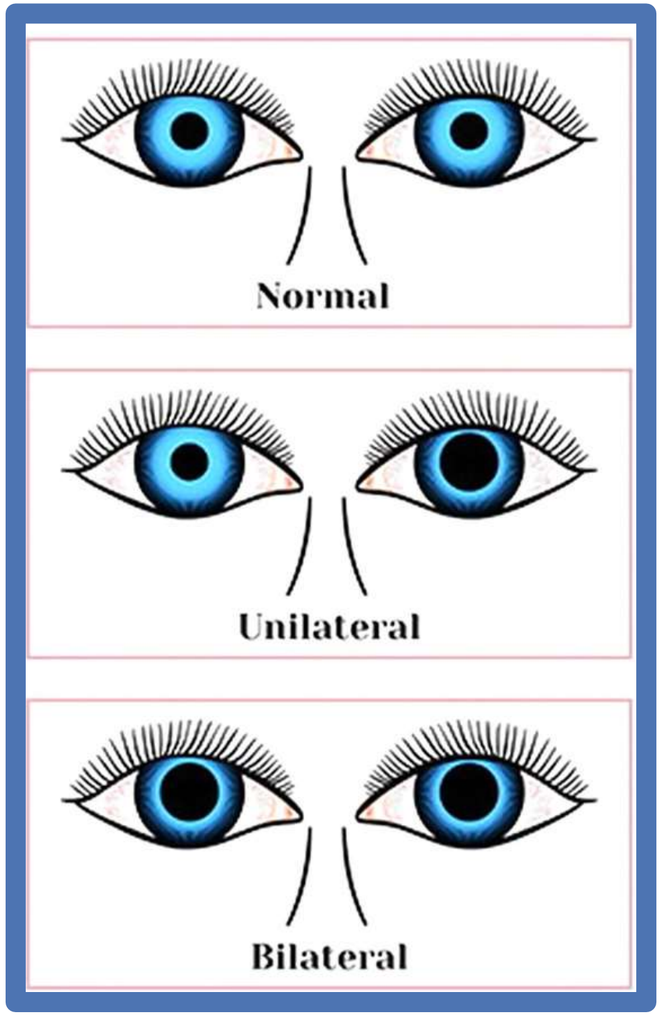
LA VALUTAZIONE PUPILLARE

LIMITAZIONI DELLA VALUTAZIONE TRADIZIONALE

pupille particolarmente miotiche

iridi di colore scuro

luce scarsa della sorgente luminosa



acume visivo dell’operatore

distanza e orientamento dell’occhio del paziente

terminologia soggettiva (es: vivace, lenta, non reattiva)

IL PUPILLOMETRO NPI-200

PUPILLOMETRO NPI-200

- è uno **scanner ottico manuale** che stimola il restringimento della pupilla con un delicato fascio di luce.
- acquisisce 90 immagini in 2,7 secondi **registrando l'intera risposta pupillare** dalla situazione di partenza al restringimento e alla ridilatazione.
- attraverso un sofisticato **algoritmo** memorizza ed elabora i dati della pupilla in termini numerici e grafici, rendendo l'esame affidabile e oggettivo

SMARTGUARD

- è monopaziente
- possibilità di memorizzare **fino a 168 misurazioni**
- possibilità di trasferire i dati rilevati in file formato Excel

DATI ANALIZZATI

NPi (Indice di risposta pupillare)

Dia (Size in inglese), diametro massimo a riposo

	Right	Left	Diff
NPi	4.1	4.3	L > R 0.2
Size	3.63 mm	3.09 mm	R > L 0.54
MIN	2.76 mm	2.47 mm	R > L 0.29
CH	24%	20%	
CV	2.86 mm/s	2.17 mm/s	
MCV	3.71 mm/s	2.72 mm/s	
LAT	0.23 sec	0.23 sec	
DV	0.73 mm/s	0.47 mm/s	

inoltre viene analizzato...

- la percentuale di costrizione (CH) o di variazione del diametro
- la latenza (LAT), cioè la differenza di tempo tra la stimolazione retinica e l'inizio della reale costrizione pupillare
- la velocità media (CV) e massima (MCV) di costrizione
- la velocità media di dilatazione (DV) intesa come recupero del diametro pupillare dopo la costrizione

NPI (Neurological Pupil Index)

L’algoritmo prodotto dal pupillomentro, mette in correlazione tutte queste variabili e produce un punteggio che definisce **l’indice della risposta neurologica pupillare** (Neurological Pupil Index o NPI).

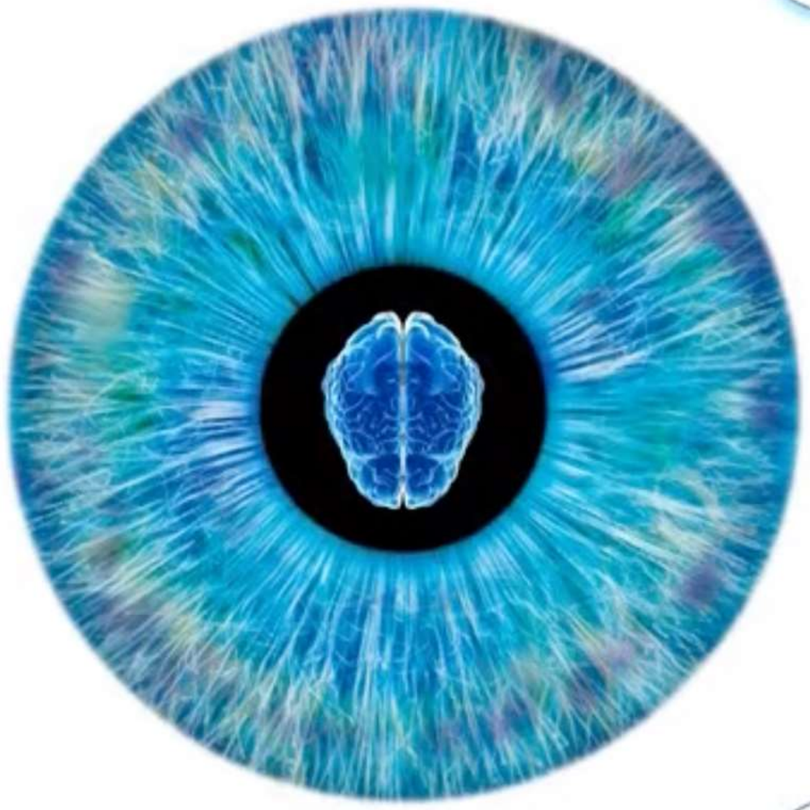
Questo indice assume un **valore da 0 a 5**: “0” corrisponde ad una reattività assente mentre “5” ad una risposta pupillare vivace. Un NPI definito “**normale**” assumerà un valore **uguale o maggiore di 3**, **inferiore a 3** sarà considerato “**anomalo**”.

Anche una differenza di NPI >= 0,7 è considerata come valore anormale.

The Neurological Pupil index™ (NPi) Pupil Reactivity Assessment Scale

Measured Value*	Assessment
3.0 – 4.9	Normal/“Brisk”
< 3.0	Abnormal/“Sluggish”
0	Non-Reactive or Atypical Response

INDICAZIONI



- Stroke
- Head Trauma
- Metabolic Disorders
- Cardiac Arrest
- Seizures
- Any Critical Illness
- Evaluation of Therapy

LA PUPILLOMETRIA AUTOMATICA: EVIDENCE BASED

Open access Protocol

BMJ Open

Outcome Prognostication of Acute Brain Injury using the Neurological Pupil Index (ORANGE) study: protocol for a prospective, observational, multicentre, international cohort study

Mauro Oddo,[1,2] Fabio Taccone,[3] Stefania Galimberti,[4,5] Paola Rebora,[4,6] Giuseppe Citerio ,[4,7] on behalf of the Orange Study Group

ORANGE è uno studio internazionale, multicentrico, prospettico e osservazionale in **pazienti con lesioni cerebrali acute**, tra cui lesioni cerebrali traumatiche, emorragia subaracnoidea aneurismatica ed emorragia intracerebrale, con l'obiettivo primario di **valutare l'associazione dell'indice NPi con l'esito neurologico e la mortalità a 6 mesi.**

Ha indagato il valore prognostico dell'indice di reattività pupillare (NPi) rilevato attraverso gli strumenti di pupillometria NeurOptics.

CONCLUSIONI: l'indice **NPi ha un valore prognostico clinicamente e statisticamente significativo per l'esito neurologico e la mortalità** dopo una lesione cerebrale acuta.

To cite: Oddo M, Taccone F, Galimberti S, *et al*. Outcome Prognostication of Acute Brain Injury using the Neurological Pupil Index (ORANGE) study: protocol for a prospective, observational, multicentre, international cohort study. *BMJ Open* 2021;**11**:e046948. doi:10.1136/bmjopen-2020-046948

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ABSTRACT

Introduction The pupillary examination is an important part of the neurological assessment, especially in the setting of acutely brain-injured patients, and pupillary abnormalities are associated with poor outcomes. Currently, the pupillary examination is based on a visual, subjective and frequently inaccurate estimation. The use of automated infrared pupillometry to measure the pupillary light reflex can precisely quantify subtle changes in pupillary functions. The study aimed to evaluate the association between abnormal pupillary function, assessed by the Neurological Pupil Index (NPi), and long-term outcomes in patients with acute brain injury (ABI).

Methods and analysis The Outcome Prognostication of Acute Brain Injury using the Neurological Pupil Index study is a prospective, observational study including adult patients with ABI requiring admission at the intensive care unit. We aimed to recruit at least 420 patients including those suffering from traumatic brain injury or haemorrhagic strokes, over 12 months. The primary aim was to assess the relationship between NPi and 6-month mortality or poor neurological outcome, measured by the Extended Glasgow Outcome Score (GOS-E, poor outcome=GOS-E 1–4). Supervised and unsupervised methods and latent class mixed models will be used to identify patterns of NPi trajectories and Cox and logistic model to evaluate their association with outcome.

Ethics and dissemination The study has been approved by the institutional review board (Comitato Etico Brianza) on 16 July 2020. Approved protocol V.4.0 dated 10 March 2020. The results of this study will be published in peer-reviewed journals and presented at conferences.

Trial registration number NCT04490005.

Correlation Between Pupillary Reactivity and Intracranial Pressure in Infants and Children

Jennifer Hayakawa, DNP, CNS, CNRN, CCRN-K; Melanie Go, BSN, RN, CCRN; Julia Meeves, MSN, RN, CCRN;
John Schomberg, PhD, MPH; William G. Loudon, MD, PhD

BACKGROUND

- Comprehensive neurological examination includes assessment of pupillary light reflex which provides information about the functional status of the optic and oculomotor nerves1.
- Changes in pupillary size and reactivity are early indicators of neurological change and are routinely used to guide clinical decision-making and interventions1.
- Automated pupillometry overcomes the limitation of subjective penlight exam improving accuracy and, reliability, and allows for trending of data over time.
- Chen et al. (2011) reported an inverse relationship between objective pupillary measurements and intracranial pressure (ICP)in *adult* patients2.
- Subsequent studies provide empirical evidence that early detection of subtle changes using pupillometers may improve clinical outcomes3.
- Despite the widespread use of automated pupillometry across diverse patient populations, there are limited studies on its use in pediatrics.

PURPOSE

- To examine the correlation between automated pupillary measurements and ICP in pediatric critical care patients.

METHODS

- Single-center, retrospective review of patients admitted to the pediatric intensive care unit for ICP monitoring assessed per standard of care using an automated, handheld NeurOpticsNPi-200 pupillometer device.
- A linear mixed-effect model with subject-level random effect was used to analyze the association between NPi and ICP measurements documented within 30 minutes of each other.
- Patients' demographic and clinical characteristics were included as covariates in the model.
- After log transformation of ICP, a generalized estimating equation (GEE) model was run with a compound symmetry covariance matrix for repeated measures.

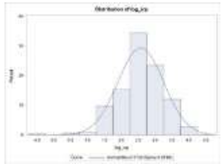
Neurological Pupil Index (NPi)

•Pupillary metrics including size, latency, constriction velocity, dilation velocity are obtained using a handheld device, and the measurement is compared against a normative model of pupil reaction to light on a scale of 0 to 5.
•An NPi value closer to 5 is considered more "brisk" than an NPi value closer to 3. An NPi score <3 represents an abnormal pupillary light reflex.

RESULTS

- Fifteen patients ranging from 3-16 years of age (M= 8.7, SD = 4) yielding over 2,600 ICP measurements were included.
- NPi was negatively associated with log ICP.

Figure 1: Following log transformation, normality assumption was satisfied



- Estimate of NPi was -0.0514; that is, a 1-unit increase in NPi was associated with 0.0514 unit decrease in log of ICP, with a significant p-value of 0.0104.

Table 1: Spearman's Rank Test Between ICP and NPi

Association	Spearman's Correlation	p-value
ICP vs. NPi	-0.079	0.0816

Table 2: GEE model for log of ICP vs. NPi, adjusting for the time between two measurements.

Outcome	Parameter	Estimate	Std	p-value
Log of ICP	Intercept	2.5725	0.1439	<.0001
	NPi	-0.0514	0.02	0.0104
	Time b/t ICP & NPi	0.0483	0.0953	0.6125

CONCLUSIONS

- Results are consistent with adult data that indicate automated assessments of pupillary reactivity inversely correlate with intracranial pressure.
- Pupillometry is a valuable adjunct to traditional invasive monitoring. An abnormally low NPi score may require emergent intervention. A baseline reading should be obtained as early as possible and routine exams should be conducted.
- Larger prospective studies are needed to validate these findings and explore if changes in pupillary reactivity precede increases in ICP.

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Children's Health of Orange County, CA
Presented May 2022

The Use of Automated Pupillometry in Children

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CHOC Children's Hospital, Orange, CA

ABSTRACT

Pupillary assessment is a fundamental component of neurological examination and can provide vital diagnostic information1-8. Evidence suggests that the traditional pen-light pupil examination is subjective, has low precision and reproducibility, and limited inter-rater reliability2-8. Automated hand- held pupillometers have recently been used to provide more objective measurements of pupillary size and reactivity. Studies suggest early detection of subtle changes using pupillometers may improve patient outcomes in adults,1,2,4-9 yet there is a paucity of literature on its use in pediatrics.

PURPOSE STATEMENT

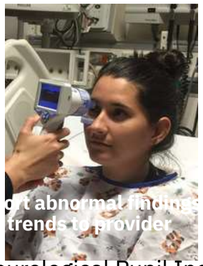
Describe the practical use of automated pupillometry in children: what it is, what types of patients we are using it on, and how it is being used.

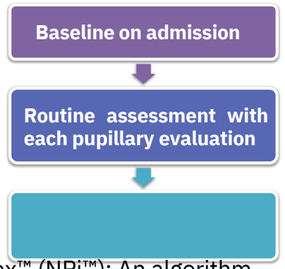
OBJECTIVES

- Review principles of automated pupillometry and how it can augment assessment.
- Discuss pupillometry in children and how one children's hospital has successfully implemented its use.
- Describe the preliminary demographics of a pediatric database.

INTRODUCTION

- The NPi®-200 is a hand-held portable infrared device that uses video recording to analyze the size and reactivity of the pupil to light.





- Neurological Pupil Index™ (NPi™): An algorithm developed to remove subjectivity from the pupillary evaluation.
- Size, latency, constriction velocity, dilation velocity is compared against a normative model of pupil reaction and graded on a scale of 0 to 5.

NPi Value	Assessment
≥ 3	Normal/Brisk
< 3	Abnormal/Sluggish
0 Non-Reactive or Atypical Response	
A difference in NPi between right and left pupils of ≥ 0.7 may also be considered an abnormal reading.	

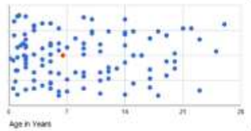
METHODS

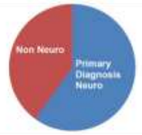
- Single center, retrospective pilot study on pediatric critical care patients that received pupillary assessment with the NPi®-200 as part of their standard of care during a three-year period.
- Establish database of pediatric measurements.
- Cross-sectional analysis of patient demographics, clinical characteristics, and practice patterns.

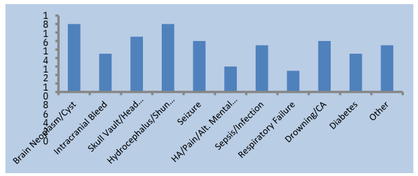
PRELIMINARY DEMOGRAPHICS

- 120 critical care patients, 3 weeks-26 years old
- 20% of subjects had ICP monitoring during stay
- > 2100 pupillometry readings

of subjects had at least one
mented NPi value of <3







IMPLICATIONS

- Adult studies suggest that pupillometry is a sensitive measure of pupil reactivity and may be an early indicator of increasing intracranial pressure (ICP)1,3-5,8,9. Need to evaluate in pediatrics.
- Early detection of subtle pupillary changes may result in more timely and effective treatments1,3,4,8,9.

Next Steps

- Complete a cross-sectional analysis of patient demographics and practice patterns.
- Examine the association between pupillometry and ICP measurements (documented within 30 minutes of each other) in pediatric patients.
- Study pupillary reactivity as an early indicator of increased ICP in infants and children.
- Multicenter study to evaluate the clinical utility of pupillometers in the pediatric patient population.

REFERENCES

References available upon request.

ACKNOWLEDGMENTS

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CHOC Children's Nursing Research 2018

ABSTRACT

La rilevazione della pupillometria automatica nell'ambito della Terapia Intensiva Pediatrica

Tale lavoro si propone di descrivere **l'utilizzo del pupillometro automatico in ambito pediatrico**, nello specifico all'interno della **UOC di Anestesia e Rianimazione Pediatrica dell'ASST Spedali Civili di Brescia - Ospedale dei Bambini.**

Il lavoro è stato condotto nel periodo compreso **tra Giugno 2020 e Luglio 2022**.

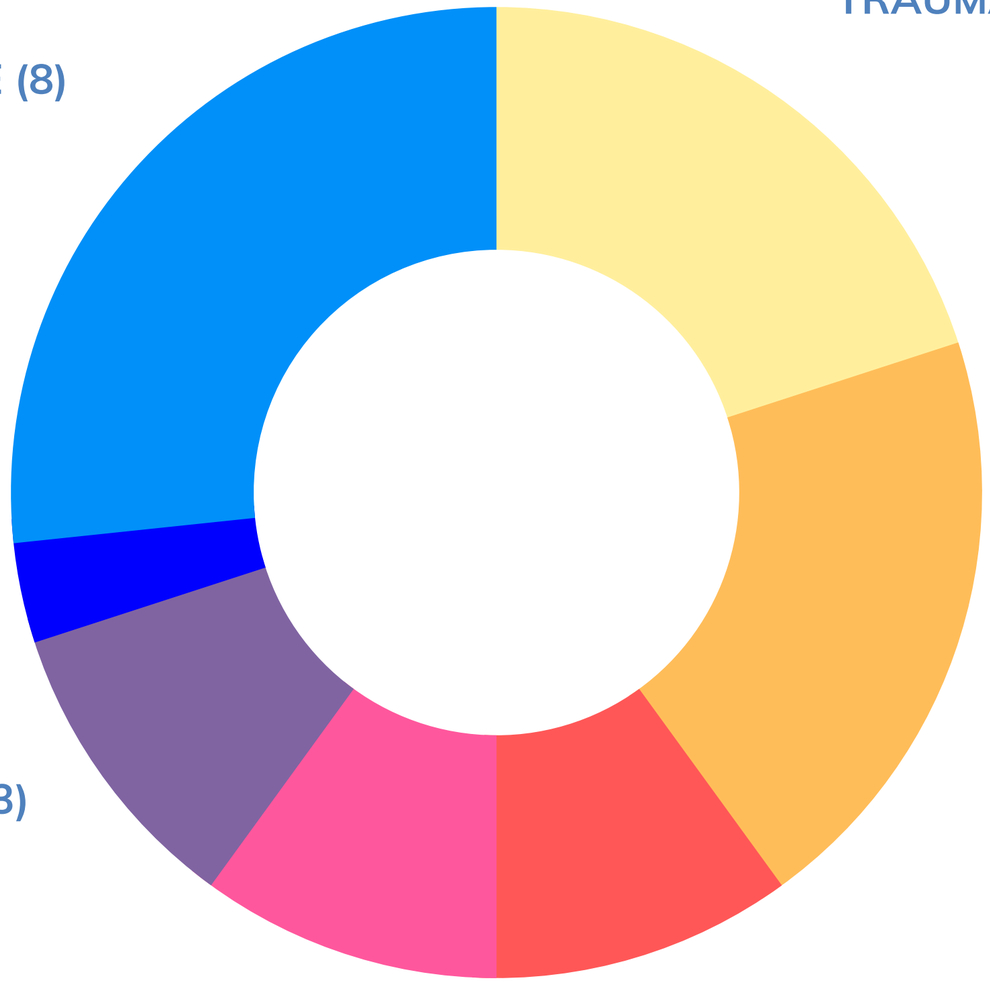
INCLUDED:

30 pazienti di età compresa tra 9 mesi e 16 anni con un'età media di 7.5 anni

NOT INCLUDED:

pazienti affetti da patologie neurovegetative

PATOLOGIE CONSIDERATE



TRAUMA CRANICO (6)
20%

ALTRE PATOLOGIE (8)
26.7%

ICTUS ISCHEMICO (1)
3.3%

NEOPLASIE (6)
20%

EMORRAGIA CEREBRALE (3)
10%

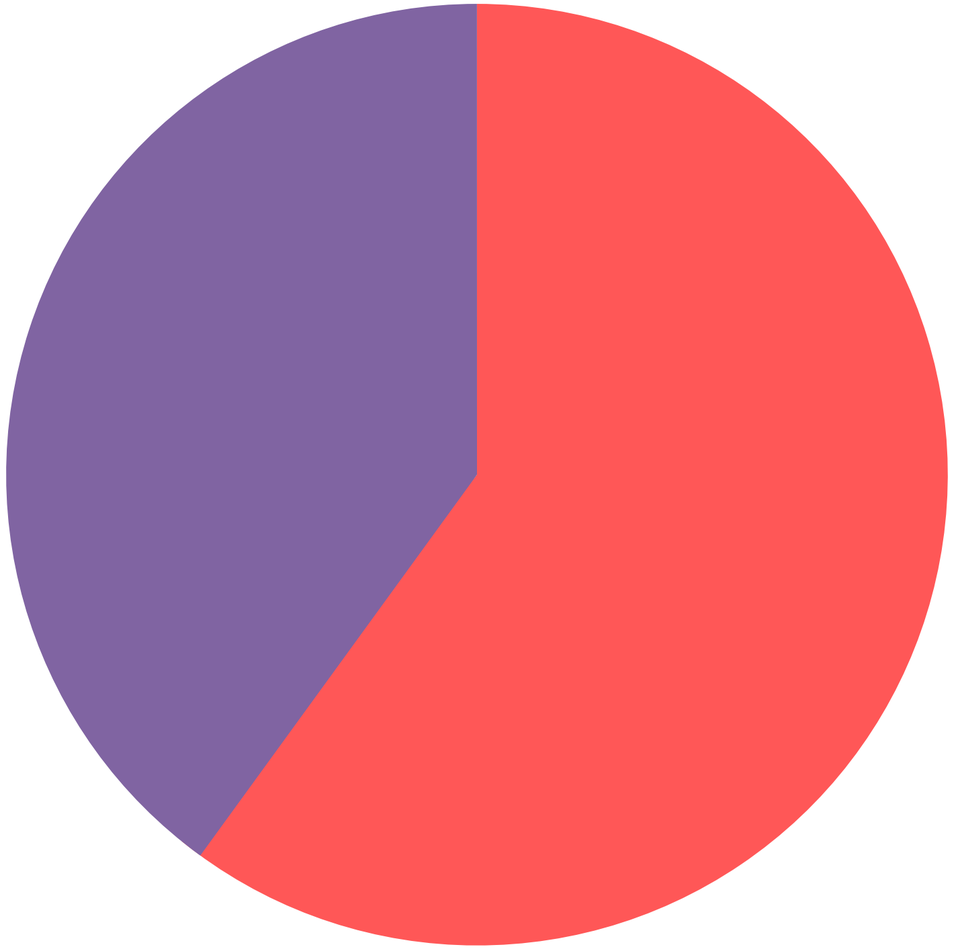
ENCEFALITE (3)
10%

EPILESSIA (3)
10%

RISULTATI

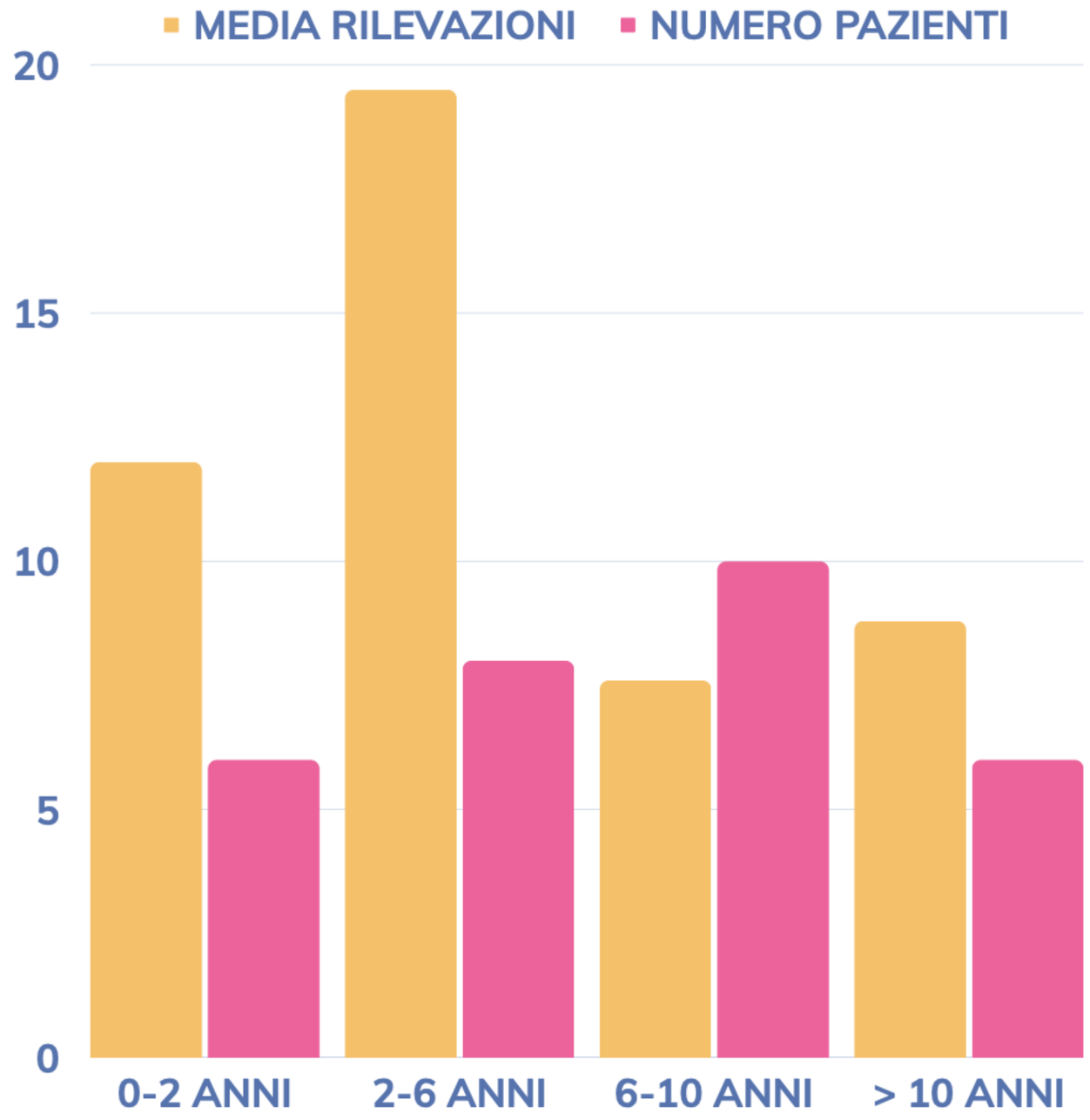
NUMERO DI RILEVAZIONI

< 5 RILEVAZIONI
40%



≥ 5 RILEVAZIONI
60%

APPLICABILITÀ



CONCLUSIONI

CONCLUSIONI

Esistono numerose limitazioni al suo utilizzo, soprattutto in pazienti coscienti e non-collaboranti per via dell'età; è emerso tuttavia che **l'età dei pazienti non pare essere un ostacolo alla misurazione dei parametri**, né questi ultimi vengano in qualche modo alterati.
È possibile tuttavia affermare che **l'utilizzo dello strumento è possibile anche in ambito pediatrico e anche in pazienti di età inferiore all'anno.**

Altri **fattori di confondimento extra-neurologici**, quali ad esempio l'utilizzo di analgo-sedazione e l'instabilità stessa del paziente critico, potrebbero aver influenzato l'esito nella rilevazione automatica del riflesso pupillare.

La rilevazione pupillare automatica è diventata pratica assodata per tutta l'equipe assistenziale, **oggettivando così un dato clinico/assistenziale fino ad ora ad alta componente soggettiva**.

PROSPETTIVE FUTURE

L’uso della pupillometria automatica in contesto pediatrico necessita di maggiori approfondimenti:

- valore di NPi di riferimento nel paziente pediatrico sano.
- punto di partenza per un futuro studio scientifico.

Suggeriamo inoltre la possibilità di avere una smartguard di dimensioni ridotte (pediatrica).

GRAZIE PER L'ATTENZIONE