Spring 5-1-2015

The Pupillometer in Practice: Identifying and Overcoming Barriers

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THE PUPILLOMETER IN PRACTICE: IDENTIFYING AND OVERCOMING BARRIERS

by

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A thesis

submitted in partial

fulfillment of the requirements for the degree of

Doctorate of Nursing Practice

in the California State University Northern California Consortium

California State University, Fresno

May 2015

APPROVED

For the School of Nursing:

We, the undersigned, certify that the doctoral project of the following student meets the required standards of scholarship, format, and style of the university and the student's graduate degree program for the awarding of the doctoral degree.

Audrey Lee Paulson
Doctoral Project Author

Sylvia Miller — Nursing

Ruth Rosenblum — Nursing

Susan Scollan-Boring RN MSCNS — Good Samaritan Hospital

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PUPILLOMETER IN PRACTICE: IDENTIFYING AND OVERCOMING BARRIERS

Problem: The pupillometer is an assessment tool that provides an accurate assessment of pupil reactivity. It is appropriate for patients who are neurologically impaired due to injury or illness. This tool, available and in use at a local community hospital, has minimal perceived importance in the Neuroscience Intensive Care Unit (NSICU), due to a disconnect experienced by the staff. The hypothesis was that understanding the pupillometer information was insufficient and that improving the knowledge would increase the perception of usefulness.

Method: Conduct a survey to determine the cause of the lack of interest and use of the pupillometer. Once the survey is complete, provide education for the staff based on gaps of knowledge identified in the survey and subsequently re-survey the group. Compare the two surveys to determine if the understanding of the information provided improves with the perceived value of the information.

Results: Sixty nurses participated in the study. The responses assisted in identifying causes of resistance to the pupillometer and gaps in the knowledge of the information it provides. This enabled the staff to start to overcome the barriers.

Conclusion: The research findings can assist nursing units with conversion of new technology that is met with resistance or a perceived lack of value, when the tool itself is proven to benefit either patient or staff in delivering care.

Audrey Lee Paulson
May 2015

DEDICATION

This paper is dedicated to Bruce, my husband, who has supported me from day one and believed in me even when I didn't believe in myself. You are the best friend and husband one could ever hope for and I am grateful every day.

ACKNOWLEDGMENTS

There are always those who deserve thanks in a project such as this. E It is humbling and yet amazing the group of individuals that have taken part and contributed. First I must thank Ruth Rosenblum who wanted me to do this topic from the day I interviewed for admission into the program. Lori Rodriguez who got me started in the right direction and Sylvia Miller, my project chair who was always there with words of wisdom and advice. The many individuals at Good Samaritan Hospital including Joseph Lotsko RN, Susan Scollan-Boring RN and my faithful editor, awesome RN and fantastic friend, Linda Higgins. Dr Sachdev for teaching me so much these past few years about neuro and being a provider and Dr Beaupre for obtaining the financial support from the hospital to assist in my education. Last, special thanks to the nurses on NSICU for without your cooperation and support, there would be no project.

The others that must be mentioned are my children, Bruce, Jacob and Jeremy, who have put up with me sitting in my room, laptop in hand, doing school work for the past two years. And finally to my mom Dori, and my daughter Jessica, the other two with Doctorates in the family. Achieving this makes me so much admirable of both of you. I am proud to be in your league.

Always,

Audrey Paulson

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CHAPTER 1. INTRODUCTION

The pupillometer is a tool that measures pupil reactivity and size. This tool is in use at a community hospital in the San Francisco Bay Area with a specialized Neurosciences Intensive Care Unit (NSICU). Although evidence supports the pupillometer as a useful assessment tool, there has been resistance to its use by the staff. The concern is that the staff lacks understanding of the information provided by the pupillometer, as demonstrated by the staff not responding or intervening when the pupillometer results indicated otherwise. The purpose of this project is to determine whether the staff understands the information provided by the pupillometer and to determine its perceived value. The hypothesis is that if there is an improvement in the understanding of the information that the pupillometer provides, there will be increased perception of the value of the tool.

Purpose

This study seeks to determine if there is a lack of knowledge regarding the information provided by the pupillometer and to determine if that is the cause of lack of perceived value of the pupillometer. In order to determine if there was a gap of either knowledge and determine the current perception of the pupillometer's value, the staff in the NSICU was surveyed. This survey assessed the current knowledge by the staff of the information provided by the pupillometer and the current perceived benefits and usefulness of the pupillometer by the NSICU nurse. Based on the knowledge deficits identified from the baseline survey, the staff received numerous interventions of education and information sharing in different formats including small group, one-on-one settings and poster boards placed on the unit. Once the educational component was complete, the participants were re-surveyed and a comparative analysis made to evaluate the effectiveness of the intervention. The goal of the study is to increase the understanding of the

pupillometer by the staff, in conjunction with an increased perceived value of the pupillometer in the clinical management of patients at risk of increased intracranial pressure.

Background

The NSICU incorporated the use of the pupillometer in order sets and it is routinely used as an assessment tool for those patients with hemorrhagic strokes. The nurses use the pupillometer and record the data obtained in their daily nursing documentation of patient care. Although the staff received initial education with the introduction of the pupillometer, there appears to be a lack of understanding of the results and how to alter or intervene in the care based on the pupillometer information obtained. The lack of appropriate interventions by the nurse when the pupillometer indicates the patient's condition is deteriorating demonstrates the possible knowledge deficits in the staffs understanding of the information obtained. The majority of staff state they are comfortable with the use and understand the information or results obtained with use of the pupillometer, when asked about their understanding. Although the nurses knew how to use the tool, they did not understand the significance of the results and what actions were required based on those results. This problem synthesizing the information precluded a lack of appropriate action. This knowledge and understanding deficit became the driving force behind conducting the study to identify and overcome the barriers to the pupillometer as experienced in the NSICU.

Historically, the pupil assessment provides information that is critical when conducting a neurological assessment (Lewis, 2007). This is even more applicable when there has been an injury to the brain that may cause an increase in the intracranial pressure (Hemphill, 2011). Although the pupillometer can be used with anyone, it is especially useful with patients who may be experiencing neurologic injury or damage (Du et al., 2005; Fountas et al., 2006). The

pupillometer has developed a method of conducting this assessment that is accurate and precise. In the past, pupil size assessment consisted of using a flashlight and the clinician observing the estimated pupil response. The reported size commonly would range from one to eight millimeters with the report describing reactivity to the light utilizing vague terms such as brisk, sluggish or normal with no clear guidance or definition of what those terms mean.

It is difficult to observe a reaction in extremely constricted pupils when flashing a light into them, thus they are often termed non-reactive, due to the clinician's inability to see subtle slight changes. However, by virtue of their constriction, the pupils react, yet it is difficult to validate or quantify this change. It is extremely difficult to detect constriction and more difficult to determine whether the response was brisk or normal. The pupillometer, a handheld instrument, measures pupil size and reactivity and, according to Hemphill (2011), the pupillometer removes operator bias, opinion and judgment. The pupillometer then provides an accurate measurement of the pupil's size and provides a precise value. The results are an accuracy increased ten-fold for the results are in tenths of a millimeter, rather than in millimeters, as typically documented (Neuroptics, 2014). Anisocoria, (unequal pupils) defined as a one- millimeter difference in size of the pupils, occurs in approximately ten percent of the population (Freeman & Aguilar, 2010). This is a normal finding for those individuals. The majority of the population does not have anisocoria, and when this occurs as a change in ones condition, can indicate a change in intracranial dynamics due to increased intracranial pressure (Freeman & Aguilar, 2010). The accuracy of the pupillometer improves the ability to detect this change.

When the individual has an injury to the brain that can cause increased intracranial pressure, the initial signs and symptoms of this clinical deterioration are often vague and easily overlooked (Freeman and Aguilar, 2010). Complaints of headache, sleepiness, nausea and subtle

changes in personality are difficult to quantify, especially when the injury is new and the clinician has no baseline to compare these changes (Enslin & Taylor, 2013). Changes that the pupillometer identifies can alert the clinicians that there may be a problem in the early stages allowing for increased awareness, closer assessment and earlier intervention (Enslin &Taylor, 2013). The pupillometer provides additional values that help identify subtle changes. The pupillometer reports the minimum and maximum pupil size, consisting of initial size and size at maximum constriction. The latency period or delay from exposure to light to initial response is the time it takes to return to baseline. The percentage of change is especially significant when one has very constricted pupils. The pupil constriction velocity decreases with increased intracranial pressure (Rosenberg, Shiloh, Savel & Eisen, 2011). The pupillometer performs these calculations quickly and accurately for the clinician.

The pupillometer provides additional values and information regarding the pupil response and reactivity. A numerical value that correlates with the reactivity provides a number from zero to five that clarifies the vague definitions of what is normal, brisk and sluggish with the higher number equating the brisker reaction (Neuroptics, 2013). This number, termed by the company that created the Neuroptics pupillometer is the Neurological Pupil Index or NPi™ (Neuroptics, 2013). This numerical value results in an accurate and consistent measurement of the pupil that is reproducible and measurable. .

With the implementation of this tool at this facility in 2012, the physician admission order sets for the subarachnoid and intracerebral hemorrhage patients are executed when patients are admitted into the NSICU include the usage of the pupillometer. The nurse must comply with the physician order, use the tool and document the patient results every four hours stating the

pupillometer readings on these specific hemorrhagic stroke patients. The NSICU sees an average of fifteen patients per month with this diagnosis so nurses competently use the pupillometer.

Theoretical Framework

The most applicable theory for this project was not a nursing theory but a technology theory. The Technology Acceptance Model (TAM) model originated in the information systems arena and Fred Davis described this model in 1983 (Davis, 1983; Aggelidis & Prodromos, 2012). Davis adapted his TAM model from the Theory of Reasoned Action (TRA) model.

The TRA model has been widely studied and universally accepted and emanates from the sociology and psychology fields. The TRA model proposes that one bases their actions or behavior based on the influences of the social forces of acceptance, social attitudes and the current social norm (Fishbein & Anzein, 1975). The Technology Acceptance Model (TAM) applies the TRA model to the human/technology interaction and the acceptance of technology.

The TAM model applies how the perception of usefulness and ease of use along with other barriers may interfere with the acceptance of new technology (Davis, 1989). This theory helps by considering factors that can influence the acceptance of newly introduced technology. This model has evolved over the past few decades and developed into a more complex model resulting in the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Aggelidis & Prodromos, 2012). In between the simplified TAM model and the complex UTAUT model is the theory selected. The Technology Acceptance Model 2 (TAM2) model is more complete and developed than the TAM model yet is not so complex that the topic is too broad to manage (Davis, 1989). The TAM 2 explores the different factors felt to influence the acceptance of new technology as defined by the TRA model while focusing attention on the perceived ease of use, and the perceived usefulness of the technology (Melas, Zampetakis,

Dimopoulou & Moustakis, 2011). The TAM 2 theory is a modified TAM approach and applies to this planned research well (Davis, 1989; Venkatesh and Davis, 2000). TAM 2 incorporates many factors that influence the intent to use the technology. Two primary factors, perceived ease of use and perceived usefulness both have strong influences on the acceptance of the technology. The influences on the perception of usefulness include the quality of the output, the results obtained from the use, and the relevance to the job that the technology impacts. The image or the acceptance by others also has impact along with the subjective norm. The individuals experience and whether mandated or optional all affects the acceptance of new technology. The TAM 2 incorporates the quality of the new technology, how the technologies impact is relevant to ones job, and how the technology's acceptance is influenced by the how difficult to use the technology is and is it helpful.

The TAM 2 is useful for determining which tools introduced by technology will have acceptance by others and seeks to identify what influences the embracement of the item while recognizing the current standards one expects the technology to offer (Venkatesh & Davis, 2000). These recognized factors are areas that influence acceptance of new technology and can identify factors that may decrease the perceived usefulness of the technology. (Venkatesh & Davis, 2000). This theory also recognizes the value of experience and application of the technology. The TAM 2 model supports this research as the equipment was proven useful and valuable yet the adoption and acceptance of this tool had not been experienced on the NSICU (Melas et al., 2011).

CHAPTER 2: REVIEW OF THE LITERATURE

Conducting a literature search using the term pupillometer has changed dramatically since the inception of this project. Initially a search using the terms “pupillometer,” “neurology,” “intensive care unit,” and “pupils” elicited few results. When searching CINAHL, the number of articles with these terms resulted in nine articles in the past ten years and 81 articles total, with all referencing the original nine articles. The library search resulted in 722 references, dating back to the late 1800s, with many referencing back to a few original works of research. The number of articles scientific in nature, and scholarly in quality, has increased over the past few years, making it difficult to stay current. The most recent search resulted in 1150 articles when conduction the search.

When performing a search using the term “pupillometer,” a few themes consistently emerge. More than one tool is called a pupillometer and this project is based on what is known as an infrared pupillometer. The term pupillometer in the ophthalmology world refers to a tool that measures the distance between the two eyes for fitting eyeglasses. This is the use of the term pupillometer discussed in the articles from the late 1800s and early 1900s. These articles were not included within the study.

Current Publications

The remaining articles have a variety of foci with some themes emerging. One such theme is those that focus on the application of the pupillometer and how it relates to use in neurology, critical care,-anesthesiology and the application with these populations. Another merging theme focuses on the use of the pupillometer and its application with pharmacologic assessment of the effects medications have on pupil size and reactivity (Matouskova, Slanar, Chytil, & Perlik, 2010). There are also the unusual foci with this rapidly growing topic applying

the pupillometer in novel new situations. Examples of these uses include the monitoring of the patient during anesthesia (Maiskowski, Burkhardt, & Puntillo, 2009). The pupillometer is being applied when determining how pupil size and response is affected in many conditions including aging, diabetes, migraines, panic disorders, and even in its application to detect lying, fear, fatigue and stress (LeDue, Greig, & Dumond, 2005). The optic arena is also finding use for this tool in different applications, and the pupillometer is proving beneficial in its use in topics such as diabetic retinopathy, glaucoma and myosis. The remaining articles vary widely in their focus with many assessing the accuracy of the different brands of pupillometers, others comparing the accuracy of the human pupil examination versus the examination using the pupillometer and the remaining discussing the pupillometer utilization in different situations.

The articles currently available using the search terms of pupillometer and adding terms of “neurology,” “critical care,” and “nursing” yielded twelve articles. Despite the overall increased influx of recent articles, no article published yet addresses resistance to the use of this tool. The tool is new and evidence to demonstrate its usefulness is also new. Since the tool is in its infancy, the amount of evidence to support its use is still under scrutiny.

CHAPTER 3: METHODOLOGY

The design of this project includes a survey of the nursing staff to provide the information and identify the areas of weakness in their knowledge base. The survey asks the staff to rate the ease of the tool and how beneficial and valuable the tool was when used (Appendix A). The survey identifies knowledge gaps to address when providing education about the pupillometer. Two months of education consisting of small group informal sessions, posters on the unit and one to one discussions with staff when the patient's diagnosis mandated the use of the pupillometer was provided to the staff. Once the education was complete, the investigator repeated the survey to assess any knowledge changes. Subsequently, the results of the survey determined if the knowledge had increased, and if the perceived value of the tool increased accordingly.

Project Design

The design of the project includes a survey-based assessment followed by an intervention, with any post-intervention survey to determine if there is any change due to the intervention. In order to implement this project, the nursing director of the NSICU agreed to the intention of this project and the goal. The Chief Nursing Officer (CNO) approved the intent to conduct research. The staff was informed that this project was planned and was asked to participate in the survey. They were informed that participation was voluntary and that they did not have to complete it. The initial survey distribution occurred during skills lab that staff attended and the majority of staff participated. The skills lab occurred in four different sessions over a month. A consent letter was posted, provided to staff and verbally explained when the survey was distributed (Appendix B). Consent was considered implied if they completed and

returned the survey. It was clear that there was no obligation to participate or compensation for doing so and there would be no repercussions for not participating.

The survey itself is two pages long (see Appendix A). The first page of the survey includes demographic information, including the number of years working as a nurse and the number of years working in the NSICU. Other demographic information includes the shift worked and their level of education. Following the demographics are questions regarding the perceived value of the pupillometer and the difficulty using the pupillometer. The final questions asks the frequency of using the pupillometer and if they use it without a physicians order.

The second page of the survey assesses the understanding of the information or results obtained from the pupillometer's use. One question instructs the nurse to assess four sets of values obtained from the pupillometer and then rate the severity of the patient's condition based on those values. There are two questions defining terms and values expected from pupillometer use. This included the terms constriction velocity or CV and NPi™. The final two questions sought to identify which patients would benefit or be appropriate for the study.

Staff was not required to identify themselves on the tool and the survey was not corrected or returned to the staff. The assessment tool for the project was used to obtain the consensus of the staff as a group and as a guide for basing an educational intervention.

There was excellent return response of the initial survey. All staff is expected to attend skills lab and all three shifts were well represented there when the initial survey was offered. An attempt was made to obtain as many responses for the second survey.

Based on the responses obtained with the initial survey, many different forms of education were provided to the staff. The focus of the education was directed to the areas identified by the survey showing a need for improvement or instruction. The survey was used to

guide the gaps in knowledge and understanding to provide opportunities for better understanding of the use and the information provided from the pupillometer.

Subjects

The subjects of the study involved the registered nurses employed and working on the dedicated twenty-bed NSICU unit at a Certified Comprehensive Stroke Center community hospital in the San Francisco Bay Area. These nurses have been trained either as a group when the NSICU opened or have been hired since and have had training with their orientation to the unit. These experienced nurses were chosen because they work with the pupillometer on a regular basis.

Criteria for Inclusion.

The criteria for participating in the survey was simple, one had to be a nurse willing to participate in the study. The study was not offered to nurses outside the hospital, as it is not known whether the problem is unique to this facility or not. It is known to be a problem at this hospital and as different hospitals have different issues unique to each hospital limiting the study to this unit in one facility provided the needed information to overcome the barriers identified. The survey was limited to those nurses who currently use the pupillometer on a routine basis.

Criteria for Exclusion.

Nurses who work in NSICU unwilling to participate were the only criteria for exclusion from this survey. Not all the staff who completed the initial survey received the second survey. Staff turnover including staff resignation, retirement or transfer to different departments resulted in loss of the second survey. An attempt was made to resurvey these individuals prior to their departure, but this was not possible for all. New nurses were hired during this time and some of these new staff members received the intervention and then completed the second survey only.

The inability to match the first survey to the second survey once all staff was surveyed was an additional element of exclusion.

Number of Participants

At the time of the initial survey, there were sixty-three nurses working in the NSICU. That number is dynamic and varies from 60 to 65 full and part-time nurses.

Recruitment Methods

The recruiting method was by invitation from the PI. The nurses appeared to increase their willingness to participate when they realized that there were no recordings of who agreed to participate and who did not. This anonymity provided for an excellent response rate.
Staff was informed ahead of time that the answers to the questions would not be provided. This absence of answers prevented any influence of their responses on the second survey.

Setting

Staff was invited to participate during skills lab initially and the second survey was provided to the staff individually or in small groups. Staff was encouraged to complete the survey independently and was discouraged from providing a response based on group discussion of the questions. They were informed they could return the survey to the investigator's unit mailbox.

Interventions

After the initial survey was completed, results were entered into an Excel spreadsheet. The demographic information was calculated and the data entered into IBM SPSS statistical software. Based on the information from this survey, numerous staff members had at least one incorrect response. There was no clear pattern with the incorrect responses and education focused on the most critical information provided by the tool. Education included small groups,

one on one, and poster presentations on the unit, followed by the second survey to determine if an improvement in the understanding of the tool and the perceived value occurred.

Instrumentation

The questionnaire was designed specifically for this study by the Project Investigator (PI). Questions considered essential knowledge for using the pupillometer and questions seeking the opinions of the staff used the Likert scale, asking ~~for~~ the staff to rate from valuable to worthless their opinion of the pupillometer. Difficulty ratings ranged from easy to difficult in the same type of scale and frequency ratings ranged from never to always. Prior to completing and testing the survey, the Clinical Nurse Specialist (CNS) of the unit completed the survey to determine the quality of the knowledge questions. The director of the department also agreed to complete the survey. Although neither of these nurses utilizes this tool on a routine basis, they answered the questions correctly. When the survey was in its final written form, five nurses who participate on a committee consisting of neurosciences nurses were asked to complete it and provide feedback. Four of those nurses indicated that they were familiar and used the pupillometer in their practice and completed the survey. Although one nurse got one question incorrect, the survey was determined to be neither too easy, nor too difficult and assessed the knowledge of the information obtained by the pupillometer accurately. These nurses agreed that this survey represented a valid representation of the information obtained from using the pupillometer.

No discussion regarding value, ease of use or frequency of use was included in the educational intervention because that would be an opinion of the staff .The goal was not to influence staff feeling about the tool, but rather to educate and assure the staff understands the information obtained by the tool. It is hoped that by increasing the understanding of the

information the tool provides, there will be natural progression of increased value of the pupillometer.

Education Intervention

The initial survey results demonstrated that many of the staff did not understand the definition of the terms from the use of the pupillometer. The survey supported the presumption that the staff was unable to determine which readings or results of the pupillometer would indicate the need to intervene or the severity of the patient's condition. This lack of knowledge guided the focus of the education provided. Small laminated cards that attach to the nurses badge were made available to the staff and posters created and placed throughout the unit. One large poster covering information from the survey was created and placed in the staff meal/break room. One to one discussion was held with nurses caring for patients with the pupillometer ordered to assure they understood how to use the tool and what the results meant. This focused educational intervention occurred over a ten week period. Education was provided to all three shifts in an attempt to reach most staff members.

Data Collection

The survey results demonstrated extreme differences of knowledge. The major misunderstanding and knowledge gaps regarding the utilization of the pupillometer and the understanding of the results explained events where there was inadequate intervention by the nurse.

Ethical Consideration (Human Subject Protections).

Prior to initiation of the study, approval was obtained from the hospital and Fresno State University Institutional Review Boards (IRB). The safeguards included anonymity of the individual and grouping of the responses, so that no individual could recognize their unique

responses. The actual surveys were in a locked cabinet, inside a locked office. The risk to those who participated in this study was determined to be minimum risk by both IRB's and participation was optional. No vulnerable populations are involved. The staff are considered my peers and although not a bedside nurse, they remain the group of nurses with whom the PI associates. As a Nurse Practitioner for the neuroscience patients, there is no supervision or disciplinary conflict between staff and researcher, and no difference in power or authority between the researcher and the staff. No patients were involved in this study and informed consent was not only verbalized but the introduction letter attached to the survey provided information about informed consent. (See appendix B)

Bias

The identity of those surveyed remained blind to the researcher. This proved beneficial when providing the educational intervention, as all staff received the same education. The survey results were entered directly into the statistical program preserving the integrity of the results and the accuracy of data entry was double-checked.

CHAPTER 4: RESULTS AND DISCUSSION

Sixty nurses completed the first survey and 57 nurses completed the second. After all surveys were complete, they were then matched together. As no names had been included, the survey pairing was based on the demographic provided by the nurse. The matching was done based first on time of employment in NSICU and years an RN. Next, they were matched according to shift and last by education. Only those that matched all four elements are included in the paired analysis. This process netted 31 pairs of surveys positively matched for the four criteria discussed.

With the initial survey, the unit had sixty-three nurses qualified to complete the survey in the NSICU. This resulted in 95% of the nursing staff responding to the survey. The matched pairs resulted in almost half of the staff completing both pre and post intervention survey. During the study, eight nurses left the unit and seven new nurses were hired.

All survey responses were entered into IBM's SPSS 21 statistics software and all entries checked for accuracy. Blank or missing responses have codes assigned to enable an accurate tally of responses and an accurate comparison of values. Survey response descriptive and frequencies calculated with the responses are divided into three groups: the paired samples, the pre intervention and the post intervention surveys. The different groupings allow for computation and calculation to determine overall scores of knowledge before and after the intervention based on total responses. The paired samples allowed for inferential analysis of the information using a paired t-test to determine if improvement occurred in the grouped responses (Pyrczak, 2004).

Demographics

The results analyzed are based on all the surveys and separately with the paired surveys. The demographics of the staff follow on Tables 1-4 and include the paired, pre and post surveys.

Table 1. Demographics of Respondents- Shift Worked

Shift Worked	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired (*n*=31)
Days	18	20	11
Evenings	23	18	10
Nights	19	18	10

Table 2. Demographics of Respondents- Degree

Degree	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired (*n*=31)
ADN	18	18	10
BS	2	2	2
BSN	35	32	19
MS	2	2	0
MSN	3	3	0

Table 3. Demographics of Respondents - Years an RN

Years RN	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired (*n*=31)
0-5	9	16	6
6-10	18	11	5
11-15	30	15	9
16-24	6	5	4
25+	10	9	7

Table 4. Demographics of Respondents - Years in NSICU

Years NSICU	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired (*n*=31)
0-5	25	23	16
6-10	15	16	5
11-15	11	10	4
16-24	3	1	1
25+	6	6	5

Knowledge Responses

The knowledge portion of the survey asked questions related to the population the appropriate with the pupillometer. Specifically the questions asked if the pupillometer is to be used only with the hemorrhagic patient and whether it can be used with a patient who has heminopsia. The additional questions asked to determine the terms one would obtain with the use of the pupillometer including NPi and constriction velocity. These questions had a myriad of responses. These responses are in Table 5 and Table 6.

Table 5. Knowledge: Yes/No questions

Question	Response	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired Pre (*n*=31)	Paired Post (*n*=31)
Hemorrhagic	**Yes**	**51**	**55**	**22**	**29**
	No	9	2	7*	2
Heminopsia	Yes	17	6*	3	1
	No	**43**	**50**	**28**	**30**

Note: Those marked with a * do not add to the total number due to missing responses. Correct response is boldface.

Table 6. Knowledge: NPi and ICP

Question	Response	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired Pre (*n*=31)	Paired Post (*n*=31)
NPi	A	22	5	14	1
	B	21	1	8	0
	C	**15**	**50**	**8**	**30**
	D	2	0	1	0
↑ ICP	A	2	1	2	1
	B	31	3	16	2
	C	21	1	10	1
	D	**6**	**52**	**3**	**27**

Note: Correct response is bold face

As the above table's shows, there was also a variety of responses with the questions relating to NPi and increased ICP. The improvement after the intervention was significant. This gap of knowledge helps to explain the lack of response by staff when the pupillometer indicated interventions are necessary.

Rating Responses

The responses are based on the opinion of those surveyed. These questions asked the individual to rate the questions regarding the difficulty of pupillometer use, how valuable it is and how frequently it is used. The responses in Table 7 are rated on a scale of 1-5 range ease of use with the higher number equaling easier to use. This mean increased on both the paired and non-paired surveys.

Table 7. Ease of Use

	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired Pre (*n*=31)	Paired Post (*n*=31)
How easy to use?				
1	5	0	4	0
2	0	0	0	0
3	7	3	5	1
4	38	13	18	10
5	10	45	4	20

The variety of responses on the question that asked the nurse to rate four different sets of values from least worrisome to most concerning provided the following results. On the initial survey, the value that would indicate that the patient is not doing well had only 15/31 (48%) answer correctly and out of the 31 pairs of surveys there were six (19%) that did not even attempt to answer the question. Five respondents (16%) answered the least worrisome for the most worrisome,-suggesting they reversed the order. On the post survey, one (3%) did not answer and 28/31 (90%) answered correctly. The remaining respondents again chose the least worrisome indicating possible confusion with the question. When examining the original surveys, it appears that two respondents did reverse their responses. The other three values all had nine (29%) individuals answer each one correctly and were reviewed due to this unusual pattern. The entries are accurate and no explanation is known for this curious finding. The responses all improved, as did the number of individuals choosing to respond at all to this question. See Appendix C for the complete results.

Table 8 addresses the frequency of pupillometer use and how valued it is. The higher number indicates the higher frequency or more valued the rating.

Table 8. Frequency of Use and Perceived Value

Question	Survey 1 (*n*=60)	Survey 2 (*n*=57)	Paired Pre (*n*=31)	Paired Post (*n*=31)
How often used?				
1	4	0	1	0
2	4	0	3	0
3	26	10	17	4
4	24	40	8	21
5	2	7	2	6
How Valuable?				
1	0	0	0	0
2	5	6	5	1
3	27	10	13	0
4	24	28	10	20
5	4	12	3	10

Note: How often was based on a scale of 1 to 5 with one= < monthly to five= almost every shift and value was also a scale of 1-5 with one=worthless to five=extremely valuable.

Table 8 explains that the tool was easier to use that and there was an increase of the frequency of use and value of the tool. The statistical analysis was conducted on the paired samples and is statistically significant with the increase in the value of the tool (n=31, $p<.01$, .433). There was also statistical significance in the frequency of use with the pupillometer as the ease of use increased. The descriptive statistics follow in Table 9.

Table 9. Descriptive Statistics Paired Means

Variable	Mean	Std. Deviation	N
How Often	3.29	.902	31
How Easy	3.55	.850	31
How Value	3.29	.938	31
Post Often	3.94	.574	31
Post Easy	4.61	.558	31
Post Value	4.29	.529	31

The mean score questions asking how easy, how often and how valuable the tool increased in the post survey responses. The results in Table 9 demonstrate that there was a positive correlation between how often (M = 3.29 SD = .902) and how easy (M = 3.55 SD = .850), r =.421, p=0.01, n =31 using the pupillometer in the pre intervention group. This correlation was statistically non-significant in the post intervention group (M = 3.94 SD = .574) and (M=4.61 SD = .558), r =.128, p=.494, n=31 possibly indicating that the original group consisted of individuals understood and used the tool more often. The research question of dependent variables including perceived value, ease of use and frequency of use and the independent variable is the education provided to the staff regarding the pupillometer had a positive correlation as well. As the knowledge increased, the value increased.

Table 10. Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Often / Post Often	-.645	.709	.127	-.905	-.385	-5.064	30	.000
Pair 2	Value / Post Value	-1.000	.966	.174	-1.354	-.646	-5.763	30	.000
Pair 3	Post Value/ Post Easy	-.323	.653	.117	-.562	-.083	-2.752	30	.010
Pair 4	Post Often/ Post Value	-.355	.709	.127	-.615	-.095	-2.785	30	.009

CHAPTER 5: CONCLUSION

This project demonstrates that the staff initially did not completely understand the information obtained from the pupillometer and that they benefitted from the additional training focused on the pupillometer. Once education was complete, the staff shows an increased perception of the value of the pupillometer, as well as an increase in the frequency of use. This study demonstrates that the perceived value of a new item of technology improves when there is improved understanding of user benefits from the technology, and with better understanding of the technology.

Education is an important influencer for improving the acceptance with the introduction of new technology in order to achieve acceptance from those using the technology. Obtaining acceptance and having the technology received with a positive attitude is essential to smooth transitions and implementation of the equipment. Acceptance with introducing new technology is easier to achieve when users are able to understand the information the technology provides and how the technology is applied to improve care. This study and the information gained from it can apply to future technology and the effective approach when introducing a new tool or piece of equipment that benefits the nurse, the patient or both.

Limitations

There are limitations to every study. One significant limitation is the lack of physician participation in the survey. Two physicians were surveyed in the initial group. They both stated that they had no idea of the information that the pupillometer provided. Those surveys were discarded due to the physician's total lack of knowledge, lack of experience using the tool and a lack of willingness to learn about the tool. They stated that there was no need to learn about the pupillometer and that there was "no need to learn about assessing pupils." This attitude

discouraged the researcher from attempting to cross that barrier. The lack of physician interest may decrease the value of the tool for all involved. Cooperation was not forthcoming and the ability to change the culture of the physicians at this facility is beyond the capacity of this study.

This study and the information gained from it can be applied to other tools of technology and their introduction to the hospital. Nurses want to do what is best but have numerous tools that are designed to augment their ability to perform their job. Education is the key to acceptance and adoption of new technology and must be done not only initially but after a period of time to reinforce what has been taught and emphasize the benefit of the technologies application to practice.

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APPENDICES

APPENDIX A: NURSING SURVEY

APPENDIX A: NURSING SURVEY

How long have you worked in NSICU?

Years

Months

How long have you been a nurse?

Years

Months

What shift do you work?

Days PM's Noc's

What is your highest level of education?

ADN BSN Other BS MSN Other MS

2. How often do you use the pupillometer?

- Almost every shift worked
- Weekly at least
- Between Weekly and Monthly
- Less than Monthly
- I never use it
- Not at all often

10. How often do you use the pupillometer without a physician order?

- Weekly or more
- Between Weekly and Monthly
- Less than Monthly
- You can use it without an order?

10. How easy is the pupillometer to use?

- Very Difficult
- Difficult
- Neither easy not difficult
- Easy
- Simple, a two year old could use it

10. How valuable do you find the information provided from the pupillometer?

THE PUPILLOMETER IN PRACTICE

- Extremely valuable
- Valuable
- Somewhat valuable
- Slightly valuable
- Worthless

6. What does the Neurological Pupil Index ™ (NPI™) mean?

- A equation that includes the patients pupil size and response.
- The patients pupils response and the likelihood of patient having increased intracranial pressure.
- The patients pupil response (brisk, sluggish etc)

7. Rate from least to most your concern with the following pupillometer results? Least = 1 and most = 4

[ ] NPI of 3.1(R) 3.3(L) size 3.81(R)3.58(L) % change 9%(R)10%(L)CV1.0(R)1.1 (L)

[ ] NPI of 4.2(R) 3.9(L) size 3.62(R) 3.88(L) % change19%(R)23%(L)CV1.5(R) 1.7(L)

[ ] NPI of 4.0(R) 3.1(L)size 3.91(R)3.31(L)% change 14% (R) 7% (L)CV1.0(R) 0.6(L)

[ ] NPI of 2.1(R) 2.7(L) size3.11(R) 3.86(L) % change 5% (R) 8% (L)CV 0.5(R) 0.7(L)

8. Which measurement suggests that there may be an increase in intracranial pressure?

- size
- NPI™
- % change
- Constriction Velocity

9. The pupillometer is only to be used with hemorrhagic stroke patients?

- True
- False

10. Can the pupillometer be used with a patient with hemianopsia?

- Yes
- No

APPENDIX B: RN CONSENT

APPENDIX B: RN CONSENT

Attention all GSH nursing staff in the NSICU and physicians in the Department of Neurology: As part of my doctoral research, I will be conducting a survey to assess knowledge and perceived value of the pupillometer. This survey will be given over the next few months. There will be no collection of names and there will be no grades given. Demographics will be asked and an assessment to determine your understanding of the values will be included. After the staff that choose to have completed this survey there will be educational classes, posters and individual sessions conducted with all staff to re-educate on the areas identified in the survey as needing discussion. When all who have taken the initial survey have had the educational intervention completed, there will be one additional survey (the same one) conducted to measure if there has been any increase in understanding of the values provided by the pupillometer. This entire activity is 100% voluntary, there is no compensation, and it will be done during working hours. No names will be collected and there is no punishment or penalty for not choosing to participate. I thank you all in advance for assisting with my education.

Audrey Paulson

APPENDIX C: SEVERITY FREQUENCIES PRE AND POST

APPENDIX C: SEVERITY RATING FREQUENCIES PRE AND POST

The number of the severity is the correct answer for clarity.

Rate Severity 1: Pre and Post

		Frequency	Percent	Frequency	Percent
Valid	1	**9**	**29.0**	**24**	**77**
	2	7	22.6	2	6.5
	3	3	9.7	1	3.2
	4	6	19.4	3	9.7
	Total	25	80.6	30	96.8
Missing	999	6	19.4	1	3.2
Total		31	100.0	100.0	100.0

Rate Severity 2: Pre and Post

		Frequency	Percent	Frequency	Percent
Valid	1	7	22.6	2	6.5
	2	**9**	**29.0**	**23**	**76.1**
	3	8	25.8	5	16.1
	4	2	6.5	0	0
	Total	26	83.9	30	96.8
Missing	999	5	16.1	1	3.2
Total		31	100.0	100.0	100.0

There was improvement and no one mistook this value for most concerning value.

Rate Severity 3: Pre and Post

		Frequency	Percent	Frequency	Percent
Valid	1	6	19.4	0	0
	2	8	25.8	5	16.1
	3	**9**	**29.0**	**25**	**80.6**
	4	2	6.5	0	0
	Total	25	80.6	30	96.8
Missing	999	6	19.4	1	3.2
Total		31	100.0	31	100

The third most severe improved from 29% to 81% and again no one confused it with the least or the most concerning values.

Rate Severity 4: Pre and Post

		Frequency	Percent	Frequency	Percent
Valid	1	5	16.1	3	9.7
	2	1	3.2	0	0
	3	4	12.9	0	0
	4	**15**	**48.4**	**28**	**90.3**
	Total	25	80.6	31	100
Missing	999	6	19.4	0	0
Total		31	100.0	100	100