ORIGINAL ARTICLE

Variability in pupil size estimation

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Emerg Med J 2006;23:440–441. doi: 10.1136/emj.2005.030247

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Accepted for publication
8 December 2005

Background: The clinical estimation of pupil size and reactivity is central to the neurological assessment of patients, particularly those with or at risk of neurological damage. Health care professionals who examine pupils have differing levels of skill and training, yet their recordings are passed along the patient care pathway and can influence care decisions. The aim of this study was to determine if any statistical differences existed in the estimation of pupil size by different groups of health care professionals.

Methods: A total of 102 health care professionals working in the critical care environment were asked to estimate and record the pupil size of a series of 12 artificial eyes with varying pupil diameter and iris colour. All estimations were performed indoors under ambient lighting conditions.

Results: Our results established a statistically significant difference between staff groups in the estimation of pupil size.

Conclusion: The demonstrated variability in pupil size estimation may not be clinically significant. However, it remains desirable to have consistency of measurement throughout the patient care pathway.

Serial assessment of pupil size and response to light is important during the initial examination and subsequent monitoring of the head-injured patient and is emphasised in all guidelines relating to emergency care.^{1–3}

As the patient progresses from initial injury through acute care to discharge, pupil assessment is performed by different healthcare professionals in many different situations. Current practice is to estimate pupil size manually and studies have shown that there is an element of subjectivity in the values recorded.^{4–5} Whilst this may not be significant with a single observer, it could introduce error within a multiple observer series. Given that the detection of a changing pupil state rather than its absolute size may require immediate intervention, it is important that measurements are reliable and inter-operator variability low. The primary objective of this study was to compare measurements of pupil size by a variety of different staff groups working throughout the critical care pathway to determine whether there was any statistically significant difference between the groups that could impact on patient care.

METHODS

Twelve artificial eyes with varying pupil size and iris colour were obtained from the National Artificial Eye Service (Blackpool, UK). Each eye was individually manufactured with a hand painted iris and artificial cornea to produce a realistic prosthesis.

A total of 102 members of staff from Newcastle Hospitals NHS Trust and the North East Ambulance Service were asked to examine the artificial eyes indoors under ambient light and record their estimations of pupil size. The eyes were presented in random order with a variation in size and colour between each consecutive eye.

The staff members were recruited from accident and emergency departments, intensive care departments, neurosurgical wards, and the ambulance service. There were a total of 68 nurses, 13 qualified medical staff, and 21 ambulance staff. The hospital based personnel consisted of 25 staff from accident and emergency departments, 12 from neurosurgical wards, 22 from neurosurgical intensive care, and 22 from general intensive care.

Univariate analysis of variance was used to compare observations between staff groups while taking into account

the artificial eye being observed. Post-hoc comparisons were undertaken using Neuman-Keuls procedure. All analyses were conducted using SPSS version 11.0.

RESULTS

A total of 102 measurements from each of the 12 artificial eyes were recorded. The mean estimation of pupil size by each group for individual artificial eyes is shown in fig 1. Estimations made by medical and nursing staff for each pupil were similar, but there was a highly significant difference between ambulance staff and each of the other groups (ANOVA $p < 0.0001$). Ambulance staff consistently estimated the pupil size 1 mm larger than the other staff. There was no significant difference in the estimations between any of the other staff groups or between staff working in neurosurgical and general intensive care units.

CONCLUSION

Using artificial eyes, we have demonstrated that there are variations in the estimation of pupil size. For medical and nursing staff these variations are small and not statistically significant. However, the results show that ambulance staff estimated pupil sizes to be larger compared with the other staff groups. Furthermore, this was in a controlled environment; in adverse conditions under which ambulance staff often operate, this inconsistency may be magnified. Therefore, our findings suggest that the potentially important baseline pupil size measurement at the scene of injury cannot be relied upon for comparison during acute care. Whilst this may not be of clinical significance, it is obviously desirable to have consistency in any series of physiological measurements.

In the study, artificial eyes have been used to permit a controlled measurement environment, but this necessarily imposes certain limitations. In human subjects, factors such as movement, anatomy, and environment would introduce further random measurement error. As pupil assessment forms an essential part of the neurological examination, ideally it should be both accurate and repeatable even when undertaken by a wide range of healthcare professionals in many different settings.

There are several important physiological measurements (for example, blood pressure and oxygen saturation) that are

Figure 1 Mean estimated pupil size of artificial eyes by each staff group. For readability, values from each staff group have been connected together.

routinely taken using automatic rather than manual processes. This has greatly facilitated their use and adoption in many different clinical areas and, to some extent, standardised both the measurement method and precision. A device that automatically measures pupil size could not only reduce the demonstrated potential differences in this basic neurological examination, but also provide other important values related to pupil dynamics.⁴⁻⁶

ACKNOWLEDGEMENTS

We are grateful to the staff who participated and the National Artificial Eye Service in Blackpool for the loan of the artificial eyes.

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Competing interests: none declared

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