Delirium Detection Based on Monitoring of Blinks and Eye Movements

Arendina W. van der Kooi, M.Sc., Marjolijn L. Rots, M.Sc., Geertjan Huiskamp, Ph.D., Francina A.M. Klijn, M.D., Huiberdina L. Koek, M.D., Ph.D., Jolanda Kluin, M.D., Ph.D., Frans S.S. Leijten, M.D., Ph.D., Arjen J.C. Slooter, M.D., Ph.D.

Objective: *To investigate whether delirious patients differ from nondelirious patients with regard to blinks and eye movements to explore opportunities for delirium detection.* **Methods:** *Using a single-center, observational study in a tertiary hospital in the Netherlands, we studied 28 delirious elderly and 28 age- and gender-matched (group level) nondelirious elderly, postoperative cardiac surgery patients. Patients were evaluated for delirium by a geriatrician, psychiatrist, or neurologist using the* Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition *criteria. Blinks were automatically extracted from electro-oculograms and eye movements from electroencephalography recordings using independent component analysis. The number and duration of eye movements and blinks were compared between patients with and without delirium, based on the classification of the delirium experts described above.* **Results:** *During eyes-open registrations, delirious patients showed, compared with nondelirious patients, a significant decrease in the number of blinks per minute (median: 12 [interquartile range {IQR}: 5−18] versus 18 [IQR: 8−25], respectively; $p = 0.02$) and number of vertical eye movements per minute (median: 1 [IQR: 0−13] versus 15 [IQR: 2−54], respectively; $p = 0.01$) as well as an increase in the average duration of blinks (median: 0.5 [IQR: 0.36−0.95] seconds versus 0.34 [IQR: 0.23−0.53] seconds, respectively; $p < 0.01$). During eyes-closed registrations, the average duration of horizontal eye movements was significantly increased in delirious patients compared with patients without delirium (median: 0.41 [IQR: 0.15−0.75] seconds versus 0.08 [IQR: 0.06−0.22] seconds, respectively; $p < 0.01$).* **Conclusion:** *Spontaneous eye movements and particularly blinks appear to be affected in delirious patients, which holds promise for delirium detection.* (Am J Geriatr Psychiatry 2014; ■:■−■)

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Received September 17, 2013; revised December 24, 2013; accepted January 2, 2014. From the Department of Intensive Care Medicine (AWvdK, MLR, AJCS), Department of Neurology and Neurosurgery (GH, FSSL), and Department of Psychiatry (FAMK), Brain Center Rudolf Magnus, University Medical Center Utrecht, the Netherlands; and Department of Geriatrics (HLK) and Department of Cardio-Thoracic Surgery (JK), University Medical Center Utrecht, the Netherlands. Send correspondence and reprint requests to Arendina W. van der Kooi, M.Sc., Department of Intensive Care Medicine, University Medical Center Utrecht, F.06.149, P.O. Box 85500, 3508 GA, Utrecht, the Netherlands. e-mail: a.w.vanderkooi@umcutrecht.nl

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INTRODUCTION

Delirium is common in elderly postoperative and critically ill patients. It is associated with increased morbidity and mortality, prolonged hospitalization, and functional decline.[1–4] Nevertheless, delirium is poorly recognized.[5] Therefore, several delirium assessment tools have become available. The Nursing Delirium Symptom Checklist is a delirium assessment tool with the highest sensitivity in postoperative patients,[6,7] whereas the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) has the highest sensitivity in ICU patients.[5,8–10]

It should be noted, however, that the studies mentioned above were done in a research setting, in which the performance of a limited number of research nurses was investigated. In daily practice, delirium screening is performed by numerous bedside nurses as part of routine clinical care. The sensitivity of the Nursing Delirium Symptom Checklist has never been investigated in a real-life, postoperative setting,[6] whereas the sensitivity of the CAM-ICU appeared to be much lower in a real-life ICU setting than in a research setting.[11] The largest study in routine clinical practice was performed in 10 different ICUs and used teams of three delirium experts as gold standard. These included psychiatrists, geriatricians, and neurologists, who evaluated together all patients. In this investigation, the sensitivity of the CAM-ICU in routine daily practice was not more than 47% and only 31% for the hypoactive form of delirium,[11] the subtype that is most difficult to recognize.[5] The specificity in this study was high (98%), but this is of minor importance, because the CAM-ICU is used for screening and not for diagnosis. The only other study on the performance of the CAM-ICU in daily practice showed a higher sensitivity (81%) but was a single-center study from the same institution where the CAM-ICU was developed, where research nurses acted as reference standard.[12]

Unfortunately, the Nursing Delirium Symptom Checklist and the CAM-ICU have more limitations, because these screenings tool may not fit well in the culture of the recovery room and ICU, which is primarily orientated on monitoring of physiologic alterations. Moreover, delirium severity cannot be quantified with the CAM-ICU. The consequence of impaired recognition of delirium is that treatment is delayed, which may impair outcome.[13]

Numerous studies have shown that delirium is associated with a change in motor activity level and that changes can already be noticed at a very early stage.[14–16] An alternative approach to detect delirium could be based on altered motor activity.[15,16] Using actigraphy, a decrease of overall activity was observed during delirium.[15] However, actigraphy requires patients to move their limbs spontaneously, which may be difficult in postoperative and critically ill patients because of pain, weakness, and the use of physical restraint. Blinks and eye movements are less affected by these issues,[17] and a decrease in eye movement velocity has been associated with a decrease of the level of consciousness.[18]

Because level of consciousness[19] and motor activity[20] can be affected in delirium, we hypothesized that monitoring of blinks and eye movements could provide a new approach for delirium detection. The objective of this study was to investigate whether blinks and eye movements are different in delirious patients compared with nondelirious patients.

METHODS

Study Design and Patient Sample

This observational single-center study was approved by the medical-ethics committee of the University Medical Center Utrecht (protocol number 11-073). The sample consisted of a homogeneous group of elderly cardiothoracic surgery patients. Patients presenting at the preoperative outpatient clinic or at the inpatient clinic the day before surgery were asked for written informed consent. Inclusion criteria were age above 50 years and written informed consent before cardiac surgery. Exclusion criteria were a history of neurologic or psychiatric disease because these may influence eye movement parameters.[21,22] Patients with a previous cerebrovascular event were not excluded unless the event resulted in electroencephalography (EEG) asymmetry. In that case, the patient was excluded after EEG recording. A sample of 28 nondelirious cardiothoracic surgery patients were matched (on group level) for age and gender to the group of 28 delirious cardiothoracic surgery patients. Sample size calculation could not be performed because prior data with this analysis method