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Patient Safety Tip of the Week

January 19, 2021

Technology to Identify Fatigue?

Our many columns listed below have highlighted the role fatigue in healthcare workers plays in medical errors and patient safety. A major problem is that we, ourselves, are not very good at recognizing when we are fatigued to a point that we are putting our patients in jeopardy. We've always suspected we will ultimately adopt technology as a means to identify fatigue earlier. In our July 29, 2014 Patient Safety Tip of the Week "The 12-Hour Nursing Shift: Debate Continues" we predicted that someday we will have the equivalent of the brief "sobriety" or "breathalyzer" test that can rapidly identify healthcare workers who are impaired by fatigue. We envision that at regular intervals beyond 8 hours (maybe even sooner) or during periods of prolonged concentration the healthcare worker will get buzzed on his/her smartphone and have to complete some simple test of reaction times or attention span. If the worker scores outside the established threshold the hospital will need to have resources in place to take over duties of that worker (completely or at least temporarily until fatigue is alleviated by, for example, a nap).

When driving long distances or at night, we use a cellphone app that uses the camera to focus on our face. When it detects any degree of eyelid drooping, it sounds an audible alarm to alert us. And it sounds an even louder alarm if it detects a repeat episode of eyelid drooping within a specified amount of time. But, obviously, we can't wait for eyelid drooping to identify fatigue in healthcare workers on the job.

Fortunately, there are a variety of other ocular phenomena that can be used to detect early fatigue. In addition to eyelid drooping, alteration of saccadic eye movements, changes in the blink rate, and changes in pupillary responses may be early signs of fatigue. In our December 2, 2014 Patient Safety Tip of the Week "ANA Position Statement on Nurse Fatigue" we noted there are other technologies that might do the trick. Studies have demonstrated alteration of saccadic eye movement metrics correlate with fatigue in several settings and studies in surgical residents confirmed such a correlation (Di Stasi 2014). Such a test could probably be easily adapted to most of today's smartphones.

Yamada and colleagues (Yamada 2018) developed a model to detect mental fatigue of younger and older adults in natural viewing situations. They collected eye-tracking data from younger and older adults as they watched video clips before and after performing

cognitive tasks. Their model improved detection accuracy, achieving 91.0% accuracy, which was 13.9% higher compared with a model based on the previous studies.

Zargari Marandi et al. (Zargari Marandi 2018) similarly studied eye movements in young and older adults during a prolonged functional computer task. The task lasted 40 minutes involving 240 cycles divided into 12 segments. Each cycle consisted of a sequence involving memorization of a pattern, a washout period, and replication of the pattern using a computer mouse. The participants rated their perceived fatigue after each segment. Parameters they measured were blink duration (BD) and frequency (BF), saccade duration (SCD) and peak velocity (SPV), pupil dilation range (PDR), and fixation duration (FD), along with the task performance based on clicking speed and accuracy. They also used a subjective (self-reported) measure of fatigue. They found that BD, BF, and PDR increased whereas SPV and SCD decreased over time in the young and elderly groups. But there were some age-related differences. Longer FD, shorter SCD, and lower task performance were observed in the elderly compared with the young group.

The Yamada and Zargari Marandi studies assessed the value of oculometrics during prolonged mentally demanding computer tasks. So, how about healthcare professionals who might similarly be engaged in prolonged mentally demanding computer tasks? How about radiologists? Our April 2018 What's New in the Patient Safety World column "Radiologists Get Fatigued, Too" highlighted a study looking at the effect of overnight shifts on performance of radiologists (Hanna 2018). The researchers used a tool for measuring fatigue and advance eye tracking technology to assess the performance of radiologists (both attendings and residents). During each session, radiologists viewed 20 bone radiographs consisting of normal and abnormal findings. The Swedish Occupational Fatigue Inventory results demonstrated worsening in all five variables (lack of energy, physical exertion, physical discomfort, lack of motivation, and sleepiness) after overnight shifts. Not surprisingly, participants demonstrated worse diagnostic performance in the fatigued versus not-fatigued state. Viewing time per case was significantly prolonged when the radiologists were fatigued. Mean total fixations generated during the search increased by 60% during fatigued sessions. Mean time to first fixate on bone fractures increased by 34% during fatigued sessions. Moreover, dwell times associated with true- and false-positive decisions increased, whereas those with false negatives decreased. Effects of fatigue were more pronounced in residents. The authors concluded that further research is needed to address and reverse the impact of such fatigue-related changes. They speculate that environmental changes (eg. lighting) and activity changes (eg. periodic breaks, moving around, etc.) might help mitigate the adverse effects of fatigue on performance.

Then, in our August 25, 2020 Patient Safety Tip of the Week "The Off-Hours Effect in Radiology" we noted some other studies assessing the impact of fatigue on radiologist performance.

So, it's no surprise that researchers have chosen radiologists as a good population in which to study the use of oculometrics for assessment of fatigue. Belgian researchers have done just that (Ward 2021). They measured saccades, blink rate, and the percentage

of eyelid closure over the pupil over time. Their setup included four displays, three RGB (red, green, blue) cameras, a gaze tracker, keyboard/mouse input (no keystrokes, only number of actions per second), and acoustic information. (The Ward article has a photo of the equipment setup used by the Belgian researchers.) And the radiologists also completed a subjective assessment of fatigue every 20 minutes. Their data confirmed that self-scored fatigue labels underestimated the occurrence of fatigue. This is really a feasibility or proof-of-concept study on which to build. It demonstrates that objective measures can be easily recorded, and some day may be used to alert radiologists to the presence of fatigue that might impair their performance in imaging interpretation.

Similar technology was used in a UK study on radiologists reading digital breast tomosynthesis (DBT) cases (Ward 2020). The researchers simply modified the mammography reading station with a three-camera eye-tracking system. Measuring blinking as an indicator of fatigue, they found that after reading 20 DBT cases, individuals were beginning to show signs of visual fatigue onset. They concluded that taking a break after 20 reports might help eliminate mistakes.

The fact that the Yamada model could detect increased mental fatigue induced by the cognitive tasks with 91.0% accuracy from just 30 seconds worth of eye-tracking data suggests this could be the oculometric equivalent of the "breathalyzer" test! We could envision implementation of such systems on almost any computer terminal that might be used by physicians, nurses, pharmacists, etc. It might even be applied to any situation in which sustained concentration for long periods is required (eg. during a surgical procedure). It might provide an easy, inexpensive way to identify fatigue in healthcare workers. But the next question is whether interventions based upon such detection can actually reduce errors in patient care. It's about time these relatively simple techniques find their niche in healthcare.

Some of our other columns on the role of fatigue in Patient Safety:

November 9, 2010 "12-Hour Nursing Shifts and Patient Safety"
April 26, 2011 "Sleeping Air Traffic Controllers: What About Healthcare?"
February 2011 "Update on 12-hour Nursing Shifts"
September 2011 "Shiftwork and Patient Safety
November 2011 "Restricted Housestaff Work Hours and Patient Handoffs"
January 2012 "Joint Commission Sentinel Event Alert: Healthcare Worker Fatigue and Patient Safety
January 3, 2012 "Unintended Consequences of Restricted Housestaff Hours"
June 2012 "June 2012 Surgeon Fatigue"
November 2012 "The Mid-Day Nap"
November 13, 2012 "The 12-Hour Nursing Shift: More Downsides"
July 29, 2014 "The 12-Hour Nursing Shift: Debate Continues"
October 2014 "Another Rap on the 12-Hour Nursing Shift"

December 2, 2014 "ANA Position Statement on Nurse Fatigue"
August 2015 "Surgical Resident Duty Reform and Postoperative Outcomes"
September 2015 "Surgery Previous Night Does Not Impact Attending Surgeon Next Day"
September 29, 2015 "More on the 12-Hour Nursing Shift"
September 6, 2016 "Napping Debate Rekindled"
April 18, 2017 "Alarm Response and Nurse Shift Duration"
July 11, 2017 "The 12-Hour Shift Takes More Hits"
February 13, 2018 "Interruptions in the ED"
April 2018 "Radiologists Get Fatigued, Too"
August 2018 "Burnout and Medical Errors"
September 4, 2018 "The 12-Hour Nursing Shift: Another Nail in the Coffin"
August 2020 "New Twist on Resident Work Hours and Patient Safety"
August 25, 2020 "The Off-Hours Effect in Radiology"
September 2020 "Daylight Savings Time Impacts Patient Safety?"

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http://www.patientsafetysolutions.com/

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