

## Patient Safety Tip of the Week

August 25, 2020

### The Off-Hours Effect in Radiology

We’ve done multiple columns on “the weekend effect” and “the after hours effect”, in which patient outcomes tend to be worse than for those during “normal” daytime hours. And, we’ve done even more columns on the impact of fatigue or derangements of normal circadian cycles on performance.

Physicians, nurses, and really all healthcare workers tend to have drop-offs in performance when fatigued. In our April 2018 What's New in the Patient Safety World column “[Radiologists Get Fatigued, Too](#)” we 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.

There have actually been several studies on the impact of fatigue on radiologist performance, but most have focused primarily on radiology residents. Now a new study has looked at the performance of radiology fellows who have completed full radiology residencies (all of whom successfully completed the American Board of Radiology board

certification following their fellowship year), comparing CT scan reading error rates during daytime or night shifts ([Patel 2020](#)).

Fellows working off-hours interpreted in-patient and emergency department examinations. The following day, attending radiologists read the studies that had been interpreted by the fellows. All fellows had at least 11 hours off prior to any off-hours assignment, and fellows took no more than 5 consecutive off-hours assignments before having at least 48 hours off work.

During the study period, off-hour day assignments on weekends and holidays were from 7:00 AM to 5:59 PM; the off-hour night assignments on weekends, holidays, and Fridays were from 6:00 PM to 6:59 AM. Off-hour night assignments on Monday to Thursday were from 8:00 PM to 6:59 AM.

Over 10,000 body CT studies were interpreted by 32 radiology fellows. Nighttime studies had error rates of 3%, compared to 2% for daytime studies, and 69% of the radiology fellows had higher error rates for night cases. Moreover, there were significantly more errors during the last half of night assignments (3.7%) compared with the first half (2.5%).

Diagnostic error rates were also lower in the first half of the day assignment from 7:00 AM to 11:59 AM compared with the second half from 12:00 PM to 5:59 PM (1.1% vs. 2.6%), but that difference was not statistically significant. Though not statistically significant, we would tend not to ignore that trend. In our May 3, 2011 Patient Safety Tip of the Week "[It's All in the Timing](#)" we noted that detection rates for polyps or adenomas during colonoscopy fell off during colonoscopies done later in a shift. And in our June 2019 What's New in the Patient Safety World column "[More on the Time of Day](#)" we noted your chance of getting an influenza vaccination or one of several preventive screening procedures also falls off when you are seen late in the day.

The authors state: "The error rate was higher despite lower work intensity during night assignments and despite having work schedules exceeding Accreditation Council for Graduate Medical Education guidelines to promote rest. The error rate was highest during the latter half of night assignments. These findings have implications for patient care and quality assurance efforts, and for designing processes to deliver the highest quality of care at lowest cost."

Of course, there may be factors other than fatigue that contribute to more errors occurring toward the end of the night shift (or toward the end of the day shift). It may be that the attention of the healthcare professional is directed toward what will happen once the shift has ended. While the Patel paper notes that all the fellows had at least 11 hours off prior to their off-hour shifts, it does not state whether they sometimes had to work during the day following the off-hour shift. Or it might be that the radiologist is rushed to finish up all work before the shift ends (eg. making sure that all dictations were done). It might even be that the time required for a safe "handoff" at the end of a shift leads to rushing the interpretation of the imaging study.

There is also one area in which we would like to have seen more data. The fellows often worked multiple consecutive night shifts (as many as five consecutive night shifts). In several of our columns we've discussed data that shows the number of performance errors in other industries increases with each consecutive night shift. For example, our November 9, 2010 Patient Safety Tip of the Week "[12-Hour Nursing Shifts and Patient Safety](#)" cited a study on shift workers in fields other than healthcare ([Folkard 2003](#)) which showed that the risk of incidents increased each consecutive day worked. For example, on average for night shifts risk was 6% higher on the second night, 17% higher on the third night, and 36% higher on the fourth night (for morning/day shifts the corresponding risks were 2%, 7% and 17%). It would have been very interesting to see in the current Patel study whether the radiology fellows made more errors on the fourth or fifth consecutive "off-hours" shift compared to the first or second.

Patel et al. note that **double reading** is an established strategy used to mitigate radiology errors. But they go on to discuss the downsides of double reading. One of those is ensuring that the result of the second reading gets back to the appropriate clinician at a time when intervention can be done. Both a patient and an emergency physician may have left the emergency department long before the result of that second reading is posted, potentially leading to "falling through the cracks". Therefore, it is important to encourage real-time readings. They also discuss more demand for **more in-house attending radiologist coverage**. But we suspect those attendings would also likely be subject to the very same factors that led to more errors in all these studies.

There is another option: **teleradiology**. We once worked with a small, rural hospital that had a unique relationship with a radiology group. The group consisted of mostly top-notch Israeli radiologists, all licensed in the US and appropriately credentialed at the hospital. There was always one radiologist on-site at the US hospital during daytime hours. But at night the readings were done via teleradiology by one of the radiologists in Israel, where it was "daytime". Clinicians at the US hospital still had the opportunity to talk with the remote radiologist and go over the imaging studies over the phone. Many hospitals in the US do use similar "nighthawk" services. With telemedicine, in general, now opening up in the COVID-19 era, it is conceivable that much radiology that is "night-time" in one location could be "daytime" in another.

In an editorial accompanying the Patel study, Bruno ([Bruno 2020](#)) notes that many academic centers have already been using in-house radiology attendings along with residents, so that all interpretations are final in real-time. He also notes that many medical centers and hospitals are relying on "nighthawk" services, akin to the teleradiology services we allude to above. Bruno notes that the key take-home message of the Patel study is that even attending-level radiologists are prone to more errors when working a night shift.

Regardless of which solutions might be put in place, it is important that hospitals and medical centers actually measure error rates to ensure that their solutions actually achieved the desired effects.

**Some of our previous columns on the “weekend effect”:**

- February 26, 2008 “[Nightmares...The Hospital at Night](#)”
- December 15, 2009 “[The Weekend Effect](#)”
- July 20, 2010 “[More on the Weekend Effect/After-Hours Effect](#)”
- October 2008 “[Hospital at Night Project](#)”
- September 2009 “[After-Hours Surgery – Is There a Downside?](#)”
- December 21, 2010 “[More Bad News About Off-Hours Care](#)”
- June 2011 “[Another Study on Dangers of Weekend Admissions](#)”
- September 2011 “[Add COPD to Perilous Weekends](#)”
- August 2012 “[More on the Weekend Effect](#)”
- June 2013 “[Oh No! Not Fridays Too!](#)”
- November 2013 “[The Weekend Effect: Not One Simple Answer](#)”
- August 2014 “[The Weekend Effect in Pediatric Surgery](#)”
- October 2014 “[What Time of Day Do You Want Your Surgery?](#)”
- December 2014 “[Another Procedure to Avoid Late in the Day or on Weekends](#)”
- January 2015 “[Emergency Surgery Also Very Costly](#)”
- May 2015 “[HAC’s and the Weekend Effect](#)”
- August 2015 “[More Stats on the Weekend Effect](#)”
- September 2015 “[Surgery Previous Night Does Not Impact Attending Surgeon Next Day](#)”
- February 23, 2016 “[Weekend Effect Solutions?](#)”
- June 2016 “[Weekend Effect Challenged](#)”
- October 4, 2016 “[More on After-Hours Surgery](#)”
- July 25, 2017 “[Can We Influence the “Weekend Effect”?](#)”
- August 15, 2017 “[Delayed Emergency Surgery and Mortality Risk](#)”

**Some of our previous columns on “after-hours” surgery:**

- September 2009 “[After-Hours Surgery – Is There a Downside?](#)”
- October 2014 “[What Time of Day Do You Want Your Surgery?](#)”
- January 2015 “[Emergency Surgery Also Very Costly](#)”
- September 2015 “[Surgery Previous Night Does Not Impact Attending Surgeon Next Day](#)”
- October 4, 2016 “[More on After-Hours Surgery](#)”
- August 15, 2017 “[Delayed Emergency Surgery and Mortality Risk](#)”
- October 24, 2017 “[Neurosurgery and Time of Day](#)”
- December 2019 “[Surgeon On-Call Shifts](#)”

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

- November 9, 2010 “[12-Hour Nursing Shifts and Patient Safety](#)”

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|--------------------|--|
| April 26, 2011     | <a href="#">“Sleeping Air Traffic Controllers: What About Healthcare?”</a>                           |
| February 2011      | <a href="#">“Update on 12-hour Nursing Shifts”</a>   |
| September 2011     | <a href="#">“Shiftwork and Patient Safety</a>  |
| November 2011      | <a href="#">“Restricted Housestaff Work Hours and Patient Handoffs”</a>                              |
| January 2012       | <a href="#">“Joint Commission Sentinel Event Alert: Healthcare Worker Fatigue and Patient Safety</a> |
| January 3, 2012    | <a href="#">“Unintended Consequences of Restricted Housestaff Hours”</a>                             |
| June 2012          | <a href="#">“June 2012 Surgeon Fatigue”</a>  |
| November 2012      | <a href="#">“The Mid-Day Nap”</a>  |
| November 13, 2012  | <a href="#">“The 12-Hour Nursing Shift: More Downsides”</a>  |
| July 29, 2014      | <a href="#">“The 12-Hour Nursing Shift: Debate Continues”</a>  |
| October 2014       | <a href="#">“Another Rap on the 12-Hour Nursing Shift”</a>   |
| December 2, 2014   | <a href="#">“ANA Position Statement on Nurse Fatigue”</a>  |
| August 2015        | <a href="#">“Surgical Resident Duty Reform and Postoperative Outcomes”</a>                           |
| September 2015     | <a href="#">“Surgery Previous Night Does Not Impact Attending Surgeon Next Day”</a>                  |
| September 29, 2015 | <a href="#">“More on the 12-Hour Nursing Shift”</a>  |
| September 6, 2016  | <a href="#">“Napping Debate Rekindled”</a>   |
| April 18, 2017     | <a href="#">“Alarm Response and Nurse Shift Duration”</a>  |
| July 11, 2017      | <a href="#">“The 12-Hour Shift Takes More Hits”</a>  |
| February 13, 2018  | <a href="#">“Interruptions in the ED”</a>  |
| April 2018         | <a href="#">“Radiologists Get Fatigued, Too”</a>   |
| August 2018        | <a href="#">“Burnout and Medical Errors”</a>   |
| September 4, 2018  | <a href="#">“The 12-Hour Nursing Shift: Another Nail in the Coffin”</a>                              |
| August 2020        | <a href="#">“New Twist on Resident Work Hours and Patient Safety”</a>                                |

## References:

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