Are PSAPs Putting the Public at Risk with Less than Optimal Shift Assignments?

Presented by
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CritiCall Pre-Employment Testing Software

www.criticall911.com/CALNENA2015
A Little About Your Presenter…

- Former Deputy Sheriff/Detective in California and Nevada
- County Search & Rescue Management-Team volunteer
- Masters and Ph.D. in Industrial & Organizational Psychology
- Twenty years of experience in HR Consulting
  - Designed dozens of employment selection devices for public-safety organizations
  - Former consultant to The International Association of Chiefs of Police, Inc.
  - Author of CritiCall pre-employment test for public safety dispatcher/calltaker positions
  - Conducted two national dispatcher/calltaker job analyses

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What Will Be Discussed

• Conducting your own review of the literature

• 12-hour shifts
  – Referred to as “Extended Shifts” in the literature

• Rotating shifts

• Graveyard/night shifts

• Combining all three
First Law of Shiftwork

• There is no such thing as a good shift system
  – But some are better than others

• Work schedules need to balance the needs of the organization and the needs of the workforce
  – These needs are not always compatible
But I read online that...

• There is a lot of very contradictory information online about shiftwork and extended shifts
• Caution is urged when you conduct your own review of the literature
• Much of the literature that is available online outside of a scholarly portal is not peer reviewed, and therefore may be someone else’s opinion or interpretation
• With that in mind, I suggest the following...
Cautiously Review Scientific Reports

• Read **all** of the Scientific Report
  – Relying on the abstract and/or specific sections of a report may lead to faulty conclusions
    • *Don’t pick what you like and disregard the rest*
    • *However, in “review” articles you must sometimes look at the preponderance of the evidence*

• **When reviewing the literature, be very aware of the number of participants (i.e., sample size)**
  – Studies that include a very small number of participants should be interpreted very cautiously
  – The larger the sample size, the closer your sample statistic will be to the true population statistic

• Findings sometimes depend on who is paying for and/or sponsoring and/or publishing the research
Cautiously Review Scientific Reports

• Caution: Different researchers use the same term to refer to different characteristics
  – e.g., The meaning of Fatigue in one study may not be the same as Fatigue in another study
  • Directly comparing the findings from different reports can be problematic

• Objective data, when appropriately used, is generally more accurate than self-reported data

• Social desirability bias
  – People have a tendency to answer in a manner that will be viewed favorably by others

• Reports are often biased by how someone is feeling at the time of the reporting
Cautiously Review Scientific Reports

• Failing to find a significant difference does not necessarily mean there is no difference

• Limitations of who participates
  – There may be systematic differences between those who participate and those who do not, which could influence the findings
# Determining Appropriate Sample Size...

**Chart 2.** Formulas for sample sizing to compare two groups according to quantitative and qualitative variables and according to pairing of cases.

<table>
<thead>
<tr>
<th></th>
<th>Quantitative variable</th>
<th>Qualitative variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-paired sample</strong></td>
<td>$n = (Sa^2 + Sb^2) \cdot \left( \frac{Z \alpha/2 + Z\beta}{d} \right)^2$</td>
<td>$n = \frac{(p1 \cdot q1 + p2 \cdot q2) \cdot (Z \alpha/2 + Z\beta)^2}{(p1 - p2)^2}$</td>
</tr>
<tr>
<td><strong>Paired sample</strong></td>
<td>$nP = \left( \frac{Z \alpha/2 + Z\beta \cdot Sd}{D} \right)^2$</td>
<td>$nP = \frac{(Z \alpha/2 + 2 \cdot Z\beta \cdot \sqrt{pa \cdot qa})^2}{4 \cdot pd \cdot (pa - 0.5)^2}$</td>
</tr>
</tbody>
</table>

$n$ – sample size (for each subgroup); $nP$ – number of pairs; $Z_{\alpha/2}$ – value of error $\alpha$, usually: $1.96$ ($5\%$); $Z_{\beta}$ – value of error $\beta$, usually: $0.84$ ($20\%$); $d$ – minimum difference between the mean values; $Sa$ and $Sb$ – standard deviation of the variable in each group; $Sd$ – standard deviation of the difference between the pairs; $D$ – mean value of the difference between the pairs; $p1$ and $p2$ – proportion of favorable results in subgroup 1 or 2; $q1$ and $q2$ – proportion of unfavorable results in subgroup 1 or 2; $pa$ – proportion of unmatched pairs for group 1; $qa$ – proportion of matched pairs for group 1; $pd$ – sum of the proportion of unmatched pairs for the two groups.

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Research Challenge: The “Criteria Problem”

• Criteria are the standards that can be used as yardsticks for measuring employees’ success or failure
  – We are unable to demonstrate beyond a shadow of a doubt that a behavior (criteria) is determined by any particular cause (Levy, 2009)

• Furthermore, do the criteria being measured in the study you are reviewing reflect important outcomes for public-safety dispatching?
Some Review Articles for These Topics


• Effects of Sleep Deprivation on Fire Fighters and EMS Responders.
  www.iafc.org/files/progssleep_sleepdeprivationreport.pdf


I cannot vouch for the quality of information contained within these articles
Circadian Rhythms

Alertness %

Time of Day

02:00 06:00 08:00 10:00 14:00 16:00 18:00 20:00 00:00

Navigating complexity. Delivering success.

Adapted from the studies of Dr. Guilhem Peremarty
Shift Work
Shift Work Can Slow You Down

• People tend to have problems when the shift they work is out of phase with their physical and social rhythms (chronotype)
  – Morningness:
    • peak alertness is in the morning
    • Earlier sleep period
  – Eveningness:
    • peak alertness is in the evening
    • Later sleep period
  – Many people are in between
Shift Work Issues

- As people get older they frequently move from an eveningness to morningness orientation
- It takes about five days for a person’s body to make the biochemical changes to allow for alertness during the night
- Errors and accidents more likely to occur at the end of longer shifts, especially when the shifts are out of balance with a person’s biological rhythms
  – Seen primarily in studies of 12-hour shifts
Night Shift

• “The period from 1 to ~8 a.m. constitutes a time span in the 24-h day when human medical and performance catastrophes are more likely to occur.”
  – Three Mile Island Nuclear Reactor – 4 to 6 a.m. (workers failed to recognize loss of core coolant)
  – Davis-Besse Nuclear Reactor (1985) 1:35 a.m. (total loss of main feedwater)
  – Rancho Seco Nuclear Reactor (1985) 4:14 a.m. (operators slow to regain control of the plant)
  – Chernobyl Nuclear Plant 1:23 a.m. (1986) (human error)

Extended Shifts
A Seminal Study

• “Performance efficiency decreased and reports of drowsiness and lack of concentration increased from the beginning to the end of the final 12-h workday.” (4 12-hour workdays; n = 6)

Self-Reported Error Rates in Nursing: Extended Shifts

- **Background**: Review study of 562 articles
  - 27 satisfied the inclusion criteria, of which 15 were rejected because of low methodological quality
  - The relationship between shift length and the number of error was examined in only **two** of the studies
  - *And the findings of those two studies were…*

Self-Reported Error Rates in Nursing

• “Although the occurrence of errors did not increase significantly until shift durations exceeded 12.5 hours per day, risks began to increase when shift durations exceeded 8.5 hours. Since errors are relatively rare, it is possible that this study lacked sufficient power to detect the effects of work hours or overtime on errors when nurses were scheduled to work shorter shifts (less than 12.5 hours).” (2004, page 208) \( (n = 393) \)

• “Longer shift durations increased the risk of errors and near errors and were associated with decreased vigilance. In particular, the risk for making an error almost doubled when nurses worked 12.5 or more consecutive hours (odds ration 1.94, \( P = .03 \))” (2006, page 34) \( (n = 502) \)

**References**


Study of Accident Records (n ~ 5000)

• An exponentially increasing accident risk was observed beyond the 9th hour at work

• For the 3 "traditional‘‘ shiftwork starting times, it was shown that, with later starting times, the relative accident risk increased dramatically beyond the 8th hour at work.

National Institute for Occupational Safety and Health (NIOSH: 2004)

• Examined a number of studies
  – Four studies reported that the 9th and 12th hours of work associated with lower cognitive function, declines in vigilance on task measures, and increased injuries
  – Two studies reported 12-hour shifts associated with more fatigue, smoking, or alcohol use
NIOSH: Shift Work and Long Work Hours

www.cdc.gov/niosh/topics/workschedules/
Comparing Performance on a Simulated 12 Hour Shift Rotation in Young and Older Workers

• There were significant differences in performance of older (35 to 56) and younger (18 to 30) participants during a simulated 12 hour shift rotation
  – Rotation: Two 12-hour day shifts (0700-1900) followed by two 12-hour night shifts (1900-0700)
  – Small sample size (n = 32)

• Performance for older subjects was consistently lower than for the younger subjects, including across shifts
  – Older subjects had decreased performance across night shifts
  – Younger subjects maintained performance on both shifts

The Effects of Sleep Deprivation on Fire Fighters and EMS Responders (2007)

• “Long work hours (shifts lasting more than 10 to 18 hours) have been clearly linked to time-dependent errors in tasks requiring vigilance and focused alertness…” (page 12)

• “Recent studies have confirm a 10 percent risk after driving [a commercial vehicle] 10 hours, and a 25 percent greater risk after driving 12 hours (Tucker, 2000)”
“The Shift Length Experiment”
aka “The Impact of Shift Length on Policing in Performance, Health, Quality of Life, Sleep, Fatigue, and Extra-Duty Employment” (2011)

• Study of police officers working 8 hour ($n = 109$), 10 hour ($n = 109$), and 12 hour ($n = 108$) shifts
• Two departments: Detroit, MI and Arlington, TX
• Officers randomly assigned to different shifts

www.policefoundation.org/shiftexperiment/
Subjective Alertness (Alertness Log)

- **Overall** average level of alertness for officers in a 12-hour shift was significantly lower than for an 8-hour shift.

- In Arlington, officers working a 12-hour shift were significantly less alert than those working a 10-hour shift.

www.policefoundation.org/shiftexperiment/
Sleepiness
Subjective Fatigue

• Overall average level of self-report sleepiness for officers in the 12-hour shift was significantly higher than those on an 8-hour shift.
Quality of Work Life (QWL)

- QWL for those working 10-hour shifts was significantly higher than those for 8-hour shifts, but not for 12-hour shifts.
- In Detroit, the 10-hour group reported significantly-higher QWL as compared to those in the 8-hour or 12-hour groups.

www.policefoundation.org/shiftexperiment/
Sleep Amount

• The average hours of sleep for officers in the 10-hour shift (mean = 7.86) was significantly greater than for those on the 8-hour shift (mean = 7.27), but not for the 12-hour group (mean = 7.63)

www.policefoundation.org/shiftexperiment/
Key Findings

• 10-hour shifts appear to have advantages over 8-hour shifts
  – The benefits of 10-hour shifts do not extend to 12-hour shifts
• 12-hour shifts may pose safety risks to officers and the public
  – Researchers note that people tend to underestimate their level of fatigue, so officers may actually be more fatigued than they reported while working 12-hour shifts
• It is for these reasons that caution should be exercised when agency leaders consider adopting 12-hour shifts
• Shift length, in this study, did not have significant impact on their measures of performance, safety, work-family conflict, or health as defined in the study

www.policefoundation.org/shiftexperiment/
Air Traffic Controllers

- Heslegrave et al (1995) reported a significant degradation of performance in 12-hour versus 8-hour shifts
- Mitchell & Williamson (2000) compared employees working 8-hour and 12-hour shifts
  - Employees on 12-hour shift had more variance in reaction time to correct responses to grammatical reasoning task


• “To reduce fatigue, shorter working periods and more frequent breaks may be more appropriate”

• “The best meta-analysis of industrial data showed that relative “risk increased in an approximately exponential fashion with time on shift such that in the twelfth hour it was more than double that during the first 8 h”

Brazilian Petrochemical Plant Study

- Study of a Brazilian Petrochemical Plant
  - Significant reduction in alertness registered at the 10th hour of all night shifts examined
  - “Long shifts are contraindicated when the physical and mental demands of the work are high and when work is monotonous but requires vigilance and alertness (such as a control room at petrochemical plants)” Page 531

European Working Time Directive

• The EU’s Working Time Directive (2003/88/EC) requires EU countries to guarantee the following rights for all workers:
  – a limit to weekly working hours, which must not exceed 48 hours on average, including any overtime
  – a minimum daily rest period of 11 consecutive hours in every 24
  – a rest break during working hours if the worker is on duty for longer than 6 hours
  – a minimum weekly rest period of 24 uninterrupted hours for each 7-day period, in addition to the 11 hours' daily rest
• paid annual leave of at least 4 weeks per year
  – extra protection for night work, e.g.
    • average working hours must not exceed 8 hours per 24-hour period,
    • night workers must not perform heavy or dangerous work for longer than 8 hours in any 24-hour period,
    • night workers have the right to free health assessments and, under certain circumstances, to transfer to day work.
Rotating Shifts

Swing

Day

Graveyard
Shift Rotation

• “The recommended rotation is from day shift to afternoon/evening to night shift”
  – NIOSH Agrees
  – A similar recommendation is made by the Canadian Center for Occupational Health and Safety
    – www.ccohs.ca/oshanswers/ergonomics/shiftwrk.html
• A lab study in 2002 under the sponsorship of the FAA did not support superiority of clockwise over counterclockwise shift scheduling
  – However, that study include a very small sample size (14 in each group)
    – see www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA405385
Rotating 12-hour Shift System
(Day-Day-Night-Night; n = 20)

• Participants’ sleep strategy changed between two night shifts.
• The first night shift caused marked increase in subjective fatigue
  – Night shifts demonstrated decline in performance
• “Most regulated systems specify that no longer than 4 h of additional work be added to any 12-h shift, and also that a minimum period of 8-10 h rest break be taken following any period of extended work” (p. 697)

Rotating Shifts

- Night shifts are rough for most people to work
- Rotating shifts put more stress on the body than night work because they force the biological clock to constantly readapt to a new work/sleep schedule
- Fixed shifts gives employees the opportunity to adjust to night shifts
Finding from Very Recent Study Submitted for Publication

• Dispatchers who worked a rotational shift schedule were two-times more likely to meet the criteria of Acute Stress Disorder than those working a more stable shift schedule.
  – ASD is an index of acute distress associated with trauma exposure disaster workers
  • Information taken from a paper under consideration for publication in the upcoming Mar/Apr issue of the Annals of Emergency Dispatch & Response
Consider: Work Hours can Affect more than just the Hours Working

• Many studies report an increase in serious traffic accidents by those who are driving home after a very long shift


Putting it Together
• It is likely that there are interaction effects of rotating shifts, extended shifts, age, chronotype, and/or other factors that apparently have not yet been sufficiently studied in relationship to one another

• In other words, just because one factor may not have a significant effect does not mean that it might not have a significant effect when combined with other factors
Is the Trade Off Worth It?

• Employees’ stated preference for 12-hour shifts is not always the best indication of whether to schedule longer shifts
  – Employees often discount their poorer performance at the end of a 12-hour shift
  – They feel the trade off between working long shifts and the “extra” time off is worth it
    • Could lead to unnecessary liability if mistakes are made
Is the Trade Off Worth It?

- Employee’s stated preference is also not always a good indicator of which shift is the most appropriate for that employee
  - Some workers may ask for specific shifts because of non job-related reasons
  - Try to match shift to worker based on job performance, if at all possible
We are starting to see litigation in this area...

Lawsuit: Ohio nurse was 'worked to death'
By Dominique DeBuquoay-Dodley, CNN
Updated 12:48 PM ET, Wed November 13, 2013

Shell Oil and Related Company Pay Over $4 Million in Overtime Back Wages Following DOL Investigation
By Christopher McKinney on September 16, 2014
Posted In Overtime Law

Shell Oil Co. and Motiva Enterprises LLC, which markets Shell gasoline and other products, have agreed to pay $4,470,764 in overtime back wages to 2,677 current and former chemical and refinery employees as a result of investigations by the U.S. Department of Labor that found violations of the Fair Labor Standards Act.

"Employers are legally required to pay workers for all hours worked," said U.S. Secretary of Labor Thomas E. Perez. "Whether in the international oil industry, as in this case, or a local family-run restaurant, the Labor Department is working to ensure that responsible employers do not experience a competitive disadvantage because they play by the rules."

The Wage and Hour Division’s Houston District Office coordinated investigations with the Gulf Coast, New Orleans, San Francisco and Seattle District Offices to ensure nationwide compliance by Shell and Motiva. The findings revealed that those eight Shell Oil and Motiva refineries failed to pay workers for time spent attending mandatory pre-shift meetings. The companies required the workers to come to the meetings before the start of their 12-hour shift. Because the companies failed to consider time spent at mandatory pre-shift meetings as compensable, employees were not paid for all hours worked and did not receive all of the overtime pay of time and one-half their regular rate of pay for hours worked over 40 in a workweek. Additionally, the refineries did not keep accurate time records.

... from both employees and those they serve.

Burgess v. Tesoro Refining and Marketing Co.
UNITED STATES DISTRICT COURT FOR THE
CENTRAL DISTRICT OF CALIFORNIA

If you have worked as a 12-hour shift worker for Tesoro Refining and Marketing Co. since May 11, 2007, you could get money from a class action settlement.

A federal court authorized this notice. This is not a solicitation from a lawyer. You are not being sued.

- This class action settlement will provide Eleven Million, Five Hundred Ninety-Nine Thousand, Nine Hundred Ninety-Nine Dollars ($11,599,999.00) to resolve a lawsuit over whether Tesoro violated California law by failing to provide shift workers at the Los Angeles and Golden Eagle Refineries with meal breaks relieved of all duty during their 12-hour shifts. It avoids the costs and risks of continuing the lawsuit, pays money to shift workers like you, and releases Tesoro from liability.

- Shift workers at the Los Angeles Refinery will be paid 50% of the meal period premium, which is one hour of pay at the base rate of pay, for each 12-hour shift worked between March 11, 2007, and March 11, 2010, up to $11,599,999.00.

- Shift workers at the Golden Eagle Refinery will be paid 50% of the meal period premium, which is one hour of pay at the base rate of pay, for each 12-hour shift worked between March 11, 2007, and March 11, 2010, up to $11,599,999.00.

Case No. 10-cv-05870 DMG (PLAx)
Supervisor Change Often Influences Turnover!

Having the same supervisor during the past year aids in the feeling of trust, which can lead to substantially lower turnover

-Harvard Business Review, April 2004
As if all of this were not enough to consider
Weight Gain?

• Clean room workers in an electronics parts factory in Asia showed increased fatigue and weight gain when compared to employees who stayed on 8-hour shift

• Average weight gain was 1 Kg on average
  – 1 kg = 2.2 Pounds

• Increased weight and other challenges remained another year later

Thank You

I hope you have found this presentation beneficial

Should you have any questions please email jkuthy@biddle.com

www.critical911.com/CALNENA2015
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Used by more than one thousand Public Safety Agencies

Used by thousands of employers and schools

Hundreds of Equal Employment Opportunity/AAP Clients Nationwide