

Liberty Mutual Research Institute for Safety

Components of Long Work Hours and Implications for Occupational and Environmental Medicine

Presentation by David A. Lombardi, PhD

Senior Research Scientist, Center for Injury Epidemiology, Liberty Mutual Research Institute for Safety, Hopkinton, MA, USA
Instructor, Department of Environmental Health, Harvard School of Public Health

Acknowledgement: Simon Folkard, PhD, DSc (Lond)

Université Paris Descartes, Faculté de Médecine, Laboratoire d'Anthropologie Appliquée, Paris, France,
Professor, Body Rhythms and Shiftwork Centre, University of Wales Swansea, Swansea, UK

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Liberty Mutual Research Institute for Safety

generating knowledge to help people live safer and more secure lives



Mission:
to advance scientific, business-relevant knowledge in workplace and highway safety, and work disability

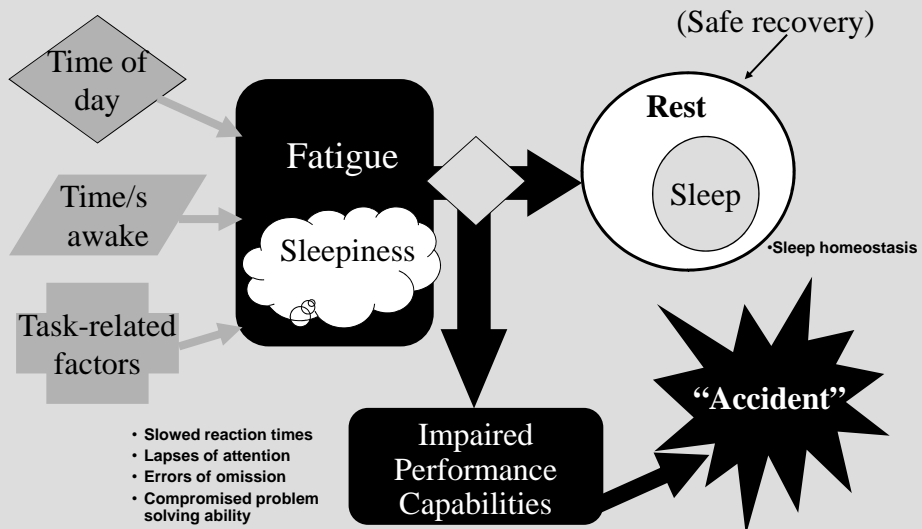
- Center for Injury Epidemiology
- Center for Physical Ergonomics
- Center for Behavioral Sciences
- Center for Disability Research



The Challenge of Long Work Hours

- Healthcare facilities rely on the ability of their institution to meet patient needs 24/7
 - ◆ Extended work hours
 - ◆ Demanding work schedules
 - ◆ Heavy workloads
- However:
 - ◆ “Long work hours, demanding work schedules and sleep/wake durations are associated with adverse outcomes on worker safety, health and well-being”
 - Caruso et al., Long working hours, safety, and health: Toward a national research agenda. *Am J Ind Med.* 2006 Nov;49(11):930-42

“Fatigue is a biological drive for recuperative rest”



Williamson, Lombardi et al., “The link between fatigue and safety”. *Acc Anal and Prev* (in Press 2010).

Performance and Long Work Hours

■ Error and Performance

- ◆ Increased risk of error due to reductions in cognitive performance mediated by sleep deficits (Lockley et al., 2004, Rogers et al., 2004)
 - 502 critical care nurses filled out 14-day logbooks
 - Error risk doubled when nurses worked 12.5 or more consecutive hours and
 - >40 hours per week increased both errors and near-errors
- ◆ Study of 2,214 middle-aged men and women, working >55 hours per week was associated with lower scores on 2 of the 5 tests of cognitive function (Virtanen et al., 2009)

Worker Safety and Long Work Hours

■ Work-related injuries and “accidents”

- ◆ >60 hours per week of work - 23% increased injury hazard rate (Dembe et al., 2005) and exponential increase in “accident” risk beyond the 9th hour of work (Hanecke, et al., 1998)
- ◆ Increased work injury and “accident” risk (Folkard and Lombardi, 2005)

■ MV crashes

- ◆ Interns: odds-ratio of 2.3 of a MVC and 5.9 for a near-miss incident after an extended work shift vs. non-extended (Barger et al. 2005)

■ Needle sticks

- ◆ Increased risk of needle stick injuries when working > 13 hour shifts (Trinkoff et al., 2007)

■ MSDs

- ◆ Eight studies that examined long work hours and had some controls for physical job demands reported a significant increase in one or more measures of MSDs (Caruso and Waters, 2008)

Health Effects and Long Work Hours

■ Potential Health Effects (Härmä M, 2003; 2006, Zhao and Turner, 2008, van der Hulst, 2003, Ko et al., 2007, Kolstad, 2008)

- ◆ Cardiovascular risk
 - Working >11 hours a day associated with a three times higher risk of myocardial infarction
- ◆ Diabetes / hypertension (mixed findings)
 - Four-fold risk of noninsulin-dependent diabetes
- ◆ BMI (mixed findings)
 - Workers with long working hours (>9 hrs) had the highest BMI and waist
- ◆ Cancer risk (mixed findings)
 - Meta-analysis has linked some cancers with shift and night-work
- ◆ “The complex mixture of causes, the close relations of several of them with general lifestyle, and the wide range of ages at which they act, make it particularly difficult to deal with confounding when examining relations to new postulated causal factors such as shift work”
 - UK’s Health and Safety Executive, 2003

Other Impacts of Non-Standard Work Hours

■ Family and Social Life (Presser, 2003)

- ◆ Child and childcare
- ◆ Potential for marital instability (less quality time)
- ◆ Leisure
- ◆ Social contacts

Impact of Sleep Loss

- Shorter sleep durations are associated with:
 - ◆ Cardiovascular disease, hypertension, diabetes, depression, and obesity (Goteib et al, 2006, Gangwisch et al. 2006, Patel 2006)
 - ◆ Transportation “accidents”
 - 635 Massachusetts nurses; rotators had twice the odds of nodding off driving to or from work and twice the odds of reported accident or error related to sleepiness than nurses who worked only day/evening shifts (Gold et al., 1992)
 - Risk for a drowsy driving episode doubled when nurses worked ≥ 12.5 consecutive hours (Scott et al., 2007)
 - ◆ Work-related injuries
 - 74,415 US workers studied across industries (NHIS); compared to 7-7.9 hours of sleep per day, adjusted risk (odds-ratio) of injury for sleeping <5 hours = 2.65, for 5-5.9 hours = 1.79, and for 6-6.9 hours = 1.40 (Lombardi et al., 2010; in review)

Trends in Work and Sleep in the US

- Long working hours are increasing while sleep duration is decreasing:
 - % working 40+ hours per week rose from 26 to 31% from 1979 to 1998 (BLS, 1999)
 - % of men and women reporting an average of <6 hours of sleep per 24-hour period increased in all age groups from 1985 to 2006 (CDC, MMWR: 2008)
- Vocational consequences need to be considered!

Healthcare Providers

- Healthcare is **a 24-hour process** and workers are often subject to: (Royal College of Physicians, 2006, Rogers, 2004)
 - ◆ Stressful working conditions
 - ◆ Increasing numbers of patients
 - ◆ Potential inadequate staffing
 - ◆ Long working hours (often without adequate breaks)
 - Scheduled shifts may be 8, 10, or 12 hours
 - May not follow traditional pattern of day, evening, or night shifts
 - ER shifts can be exceptionally long >12 hours
 - Often highly incentivized

Healthcare Providers

- Growing consensus of a potential shortage of physicians in the US is imminent (Salsberg and Grover, 2006)
- >1/3rd of full-time physicians worked 60 hours or more a week in 2006 (BLS, 2006)
- Data from the CTS Physician Survey from 1996 to 2001 suggest: (Shiotani et al., 2008)
 - Average weekly hours in patient care ↑ from 47.0 to 49.0
 - For all medically related activities, weekly avg. is 57.2 hrs

Weekly Doctors Work Hours by Specialty

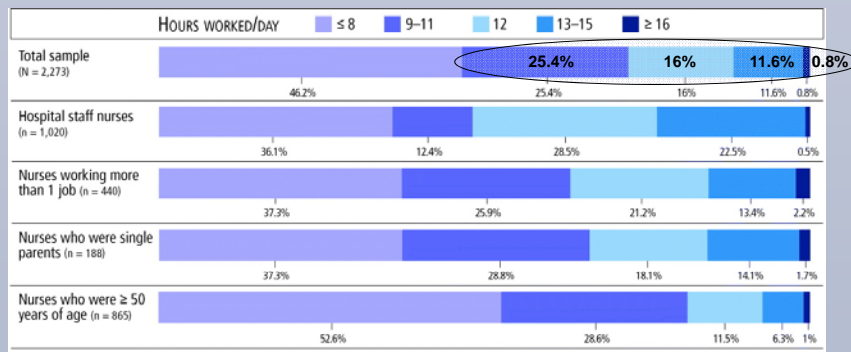
Table 1. Characteristics of the Selected Specialties

Specialty	Lifestyle	Average Income, \$ in Thousands	Average Work Hours per Week	Years of Graduate Medical Education Required
Anesthesiology	Controllable	225	61.0	4
Dermatology	Controllable	221	45.5	4
Emergency medicine	Controllable	183	46.0	4
Family practice	Uncontrollable	132	52.5	3
Internal medicine	Uncontrollable	158	57.0	3
Neurology	Controllable	172	55.5	4
Obstetrics and gynecology	Uncontrollable	224	61.0	4
Ophthalmology	Controllable	225	47.0	4
Orthopedic surgery	Uncontrollable	323	56.0	5
Otolaryngology	Controllable	242	53.5	5
Pathology	Controllable	202	45.5	4
Pediatrics	Uncontrollable	138	54.0	3
Psychiatry	Controllable	134	48.0	4
Radiology (diagnostic)	Controllable	263	58.0	4
Surgery (general)	Uncontrollable	238	60.0	5
Urology	Uncontrollable	245	60.5	5
Average for the above specialties	Not applicable	208	53.9	4

Source: Dorsey. JAMA, Vol 290(9).Sept 3, 2003.1174.

How Much Are Nurses Now Working?

Percent of RN Respondents Reporting Selected Work Schedule Characteristics*



*Source: Trinkoff et al., American Journal of Nursing 106(4):60-71 (2006).

Top 10 reasons for registered nurses to have occupation other than nursing*

Top 10 Reasons for Other Occupation*	Number in Sample*	Estimated	
		Number*	Percent
Career change	859	79,274	65.8
Burnout/stressful work environment	591	54,079	44.9
Scheduling/too many hours	550	49,873	41.4
Salaries too low/better pay elsewhere	434	41,007	34.0
Inadequate staffing	425	40,162	33.3
Taking care of home and family	380	35,724	29.6
Physical demands of job	366	33,833	28.1
Skills are out-of-date	269	24,827	20.6
Lack of collaboration/communication	274	24,718	20.5
Liability concerns	273	24,609	20.4

*Adapted from Appendix A, Table 40, Findings from the 2004 National Sample Survey of Registered Nurses

Work Hour Limitations

- Aim of work hour limitations is to ensure acceptable levels of health and safety risks to providers and patients
- In 2003, the ACGME¹ passed work hour limitations for all US resident training programs
 - ◆ Limits work week to 80 hours and continuous time on duty to 24 hours (+6 hours all tasks)
 - ◆ Requires 24 consecutive hours off out of every 7 days
- In 2004, IOM² recommendations for Nursing staff
 - ◆ States should prohibit nursing staff from providing patient care in excess of 12 hours in any given 24-hour period and in excess of 60 hours per 7-day period.
- In 2004, the EU enacted a law that in 2009 reduced work hour limits of all physicians and residents from 58 to 48 hours work/week

¹Accreditation Council for Graduate Medical Education

²Institute of Medicine: Keeping Patients Safe: Transforming the Work Environment of Nurses. Washington, DC: National Academy Press, 2004.

Work Hour Limitations

- **Current Debate** (Landrigan et al., 2007, Britt et al., 2009)
 - ◆ Compliance?
 - ◆ Is there measurable impact on worker and patient safety?
 - ◆ Is there available staff to handle teaching hospitals' caseloads and provide quality care, or are workloads simply compressed?
 - ◆ Over-restrictive? Do residents get enough time for training?
 - ◆ Is the problem as simple as total work hours?
- We propose a "Risk Index" to evaluate the work schedule (in addition to total work hours) to help ensure maximum safety (Folkard and Lombardi, 2004; 2006)

Modeling the Components of Long Work Hours: A "Risk" Index

- **Meta-analysis of epidemiologic studies of trends in injuries across industries to estimate the risk of errors associated with shift systems:**
 - ◆ The relative risk for different lengths of shift (4 studies)
 - ◆ The relative risk across type of shift (8-h, morning, afternoon, night) shifts (8 studies)
 - ◆ The relative risk across spans of four successive day (5 studies) or night shifts (7 studies)
 - ◆ The interval between rest breaks (single study!)

Folkard S, Lombardi DA. Modelling the impact of the components of long work hours. Am J Ind Med, 2006 Nov; 49(11):953-63.

Acute injuries and “accidents”

- Can be “pin-pointed” in time.
- Can be related to specific features of work schedules

But

- Need a large numbers of incidents!
- Need to ensure that the exposure is either constant, or that it can be corrected for (which often it isn't or can't be)
- Need to ensure that the probability of reporting an “accident” or injury is constant (which often it may not be)

Challenges with using health measures

- We have chosen this approach in view of the various methodological difficulties in attempting to examine the impact of long work hours on health measures:
 - ◆ Some health problems have relatively long induction times (e.g. cancer)
 - ◆ “Self-selection” may confound results (e.g. healthy worker effect)
 - ◆ Work hours may be confounded with age and experience
 - ◆ May be unclear what causes what (e.g. long hours & reduced cardiovascular risk)

Modeling the Components of Long Work Hours

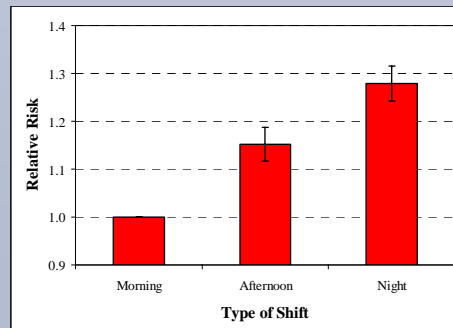
- Several consistent trends in incidents (i.e., injuries or accidents) associated with features of shift systems were identified

📖 *Definition:* Relative risk (RR) is a ratio of the probability (risk) of the event occurring in the exposed group versus a non-exposed group.

Trends in Injury and Accident Risk

Relative Risk across the three shifts (Error bars = 95% CIs)

- Type of Shift: Workers on an eight-hour night shift have a 28% greater risk of experiencing an accident or injury than workers on morning shift



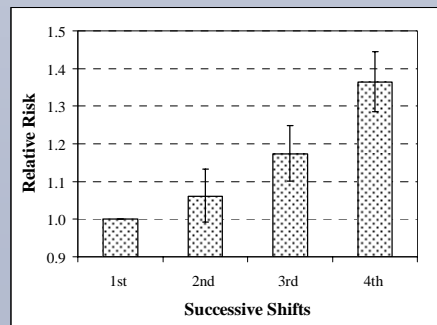
Source: Folkard S, Lombardi DA, 2006.

Trends in Injury and Accident Risk

Relative Risk over four successive night shifts (Error bars = 95% CIs)

- Compared to first night, risk is about 6% higher on the second night, 17% higher on the third night, and 36% higher on the fourth night

Successive Night Shifts



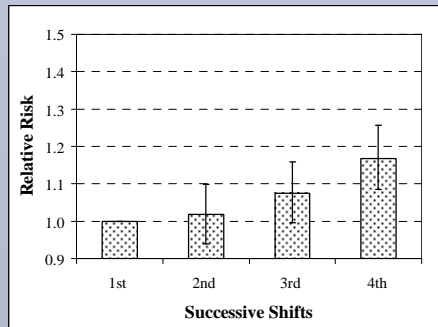
Source: Folkard S, Lombardi DA, 2006.

Trends in Injury and Accident Risk

Relative Risk over four successive morning/day shifts (Error bars = 95% CIs)

- Compared to the first day, risk is 2% higher on the second morning / day, 7% higher on the third, and 17% higher on the fourth

Successive Day Shifts

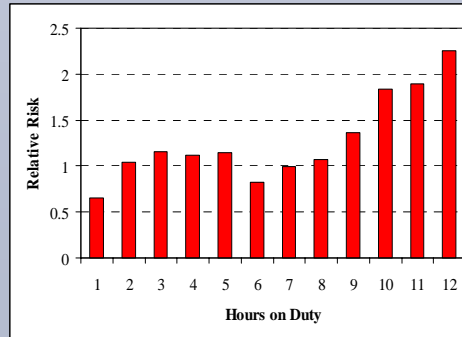


Source: Folkard S, Lombardi DA, 2006.

Trends in Injury and Accident Risk

Mean Relative Risk over hours on duty

- Hours on Duty:**
 apart from a slightly heightened risk from the second to fifth hour, risk increase is approximately exponential with time on shift

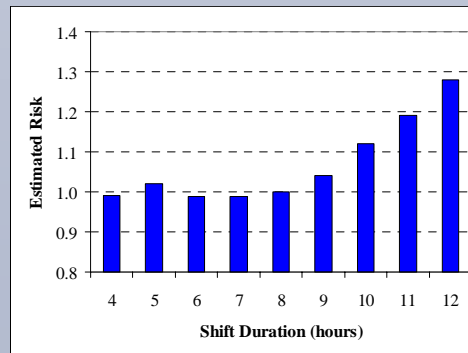


Source: Folkard S, Lombardi DA, 2006.

Trends in Injury and Accident Risk

Estimated Relative Risk on different lengths of shift

- Shift Length:**
 relative to 8 hr shifts, 10 hr shifts are associated with a 13.0% increased risk and 12 hr shifts with a 27.5% increased risk

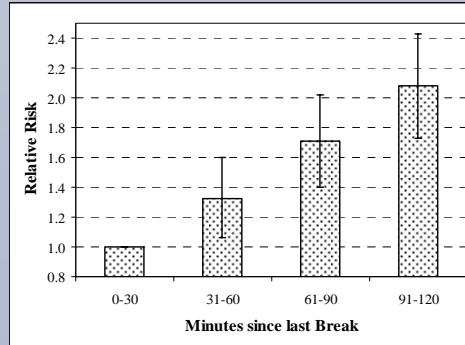


Source: Folkard S, Lombardi DA, 2006.

Trends in Injury and Accident Risk

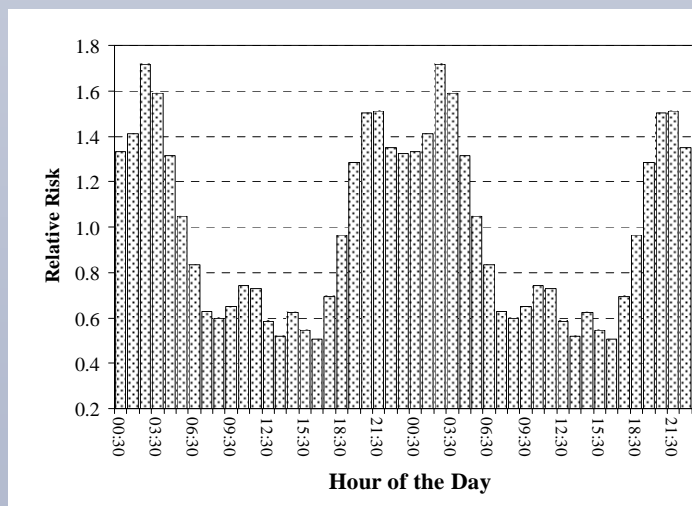
Relative Risk between 2-hourly breaks (Error bars = 95% CIs)

- **Rest breaks:** Risk increases between successive breaks and doubles by the last 30-min period before next break
 - ◆ No evidence trend differs for day and night shifts or for successive periods of 2 hours of continuous work within a shift



Source: Folkard S, Lombardi DA, 2006.

Circadian Effects: Time of 24 Hour Day



Source: Folkard S, Lombardi DA, Spencer MB. *Estimating the circadian rhythm in the risk of occupational injuries and "accidents."* Chronobiol Int, 2006;23(6):1181-92.

Summary of Trends

- Shift Length > 8hrs = Higher Risk
- Risk ↑: Night > Afternoon > Day
- Risk ↑ with Successive Days
- Risk ↑ with Successive Nights
- Risk ↑ with Longer Time Between Breaks

Modelling relative risk of work schedules

- We can estimate the Relative Risk for a work schedule by taking into account
 1. The **length** of the shifts (8h, 12h, etc)
 2. The **type** of shifts (Morning, Night, etc)
 3. The **number** of shifts in the span (3, 4, etc)
 4. The **interval** between breaks (2h, 4h, etc)

Source: Folkard S, Lombardi DA, 2004; 2006.

“Risk Index” Model

$$RR_S = RR_T + CR_N + CR_L + CR_B$$

where:

RR_S = Relative risk for the span of shifts

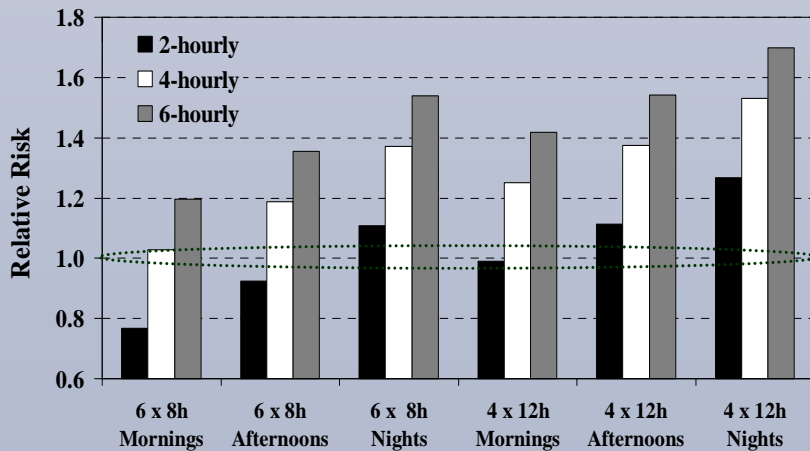
RR_T = Relative risk for the first shift of this type in the span

CR_N = Change in risk for the number of successive shifts of that type in the span

CR_L = Change in risk for the length of the shifts in the span

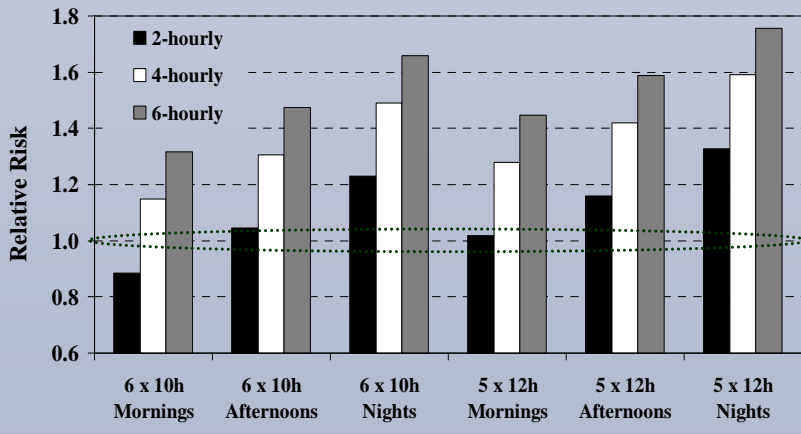
CR_B = Change in risk for the interval between breaks

Relative risk over 48 hours per week: 4 day vs. 6 day shifts with varying breaks



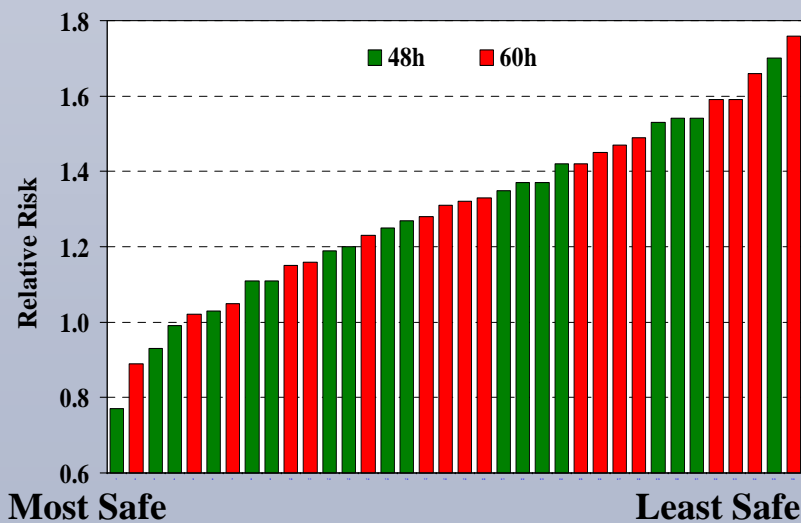
Note: Referent RR is set at 1.0 for 5 successive 8h day shifts with 4 hours between breaks

Relative risk over 60 hours per week: 5 day vs. 6 day shifts with varying breaks



Note: Referent RR is set at 1.0 for 5 successive 8h day shifts with 4 hours between breaks

Rank ordering of the various 48h and 60h work schedules



Comparison of the various 48h and 60h work schedules

	48 h Schedules	60h Schedules
Mean Relative Risk (RR)	1.26	1.34
RR Range	0.77 - 1.70	0.89 - 1.76
No. above 1.50 "cut-off"	4	4
No. above 1.40 "cut-off"	5	8
No. Safest Half	10	8

"Risk Index" advantages

- Based on "real life" trends in the risk of injuries and accidents (rather than measures of fatigue or performance on laboratory tasks)
- Has a high "Face Validity"
- The output in terms of "Relative risk" allows us to make informed decisions as to whether a schedule is "acceptable"

Limitations of the “Risk Index”

- Does not consider “abnormal” shift start times
- Do not take into account short periods of off-duty between shifts (i.e. “quick returns”) or the recuperation afforded by rest days
- Does not account for individuals who show circadian adjustment to their permanent work schedule
- Currently, based solely on injury research does not address health outcomes (challenges in evaluating health risk data)

HSE (UK) Fatigue and Risk Index

Folkard et al., 2008

- Can evaluate complex schedules
- Takes into consideration type of work and commuting time
- Incorporates Fatigue Research into Risk Index
- Graphical Representation of the Work Schedule providing separate Fatigue and Risk Indices

“The Development of a Fatigue / Risk Index for Shiftworkers, the new Fatigue/Risk Index Calculator” and the associated user guide can be downloaded for free from: <http://www.hse.gov.uk/research/rrhtm/rr446.htm>

Joint Commission on Accreditation of Healthcare Organizations (JCAHO) Recommendations (2006)

- Maintain an organization wide culture of safety
 - ◆ Goal - prevent patient harm associated with health care worker fatigue
- Implementation expectation of the organization:
 - ◆ Identify fatigue as unacceptable risk to patient care
 - ◆ Identify tasks affected by levels of fatigue
 - ✓ bar excessively fatigued workers or those on extended duty hours from performing fatigue-sensitive tasks
 - ◆ Takes actions to minimize impact of fatigue on patient safety
 - ✓ scheduling work hours and on-call periods to minimize fatigue, limiting working hours, etc

Summary

- Work hour limitations may not always keep safety risks within acceptable limits
- An alternative approach is to:
 - ◆ Set an “acceptable” level of risk, and
 - ◆ Do not allow work schedules that could be shown to fall outside that limit
- Those making schedules should make adequate work time and workload adjustments to ensure worker and patient safety (short and long-term)!

Questions or Comments?

David A. Lombardi, Ph.D.
Senior Research Scientist
Center for Injury Epidemiology
email: david.lombardi@LibertyMutual.com

Liberty Mutual Research Institute for Safety
71 Frankland Road
Hopkinton, MA 01748
phone: (508) 497-0210
fax: (508) 435-3456

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