Variations in Sleep and Performance by Duty Start Time in Short Haul Operations

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Short Haul Pilots can Experience Circadian Misalignment

Clock Time

Approximate time of day

Psychomotor performance reaction time (ms)

- Slowest 10%
- Mean
- Median
- Fastest 10%

Trucker fatalities by time of day

Dijk and Lockley, JAP 2002
Circadian Nadir = Poorest Performance and Highest Sleep Drive

Dijk and Lockley, JAP 2002
Circadian Wake Maintenance Zone = Lowest Sleep Drive

Dijk and Lockley, JAP 2002
Short Haul Aviation Study

• Systematic evaluation of schedule types
  – Baseline, early, evening, night schedules
  – Assessment during duty days and days off

• Outcomes
  – Hassle factors
  – PVT on iPod
  – Actigraphy
  – Sleep logs
  – Sleepiness scales, countermeasure logs
  – Urine collection for melatonin assessment

• Data Mining
  – Operational outcomes
  – Correlations with fatigue measures

n = 44 study
n = 13 urine collection
Study Protocol
Sleep Outcomes

![Sleep Duration Graph](image_url)

- **Sleep Duration (h)**
- **Day on Schedule**
- **Baseline**
- **Early Starts**
- **Midday Starts**
- **Late Starts**

* indicates significant difference.
Performance Varied by Duty Start Time

Reaction Time (ms)

Day on Schedule

1 2 3 4 5

Legend:
- Triangles
- Circles
- Squares

Signs:
- *
- **
Aircraft Performance Exceedance and Anomaly Detection

- $n = 1644$ flights
- Flights coincided with collection of human performance data

<table>
<thead>
<tr>
<th>Severity Type</th>
<th>Min</th>
<th>Max</th>
<th>Sum</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0</td>
<td>8</td>
<td>2499</td>
<td>2.19</td>
<td>1.64</td>
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<tr>
<td>Medium</td>
<td>0</td>
<td>4</td>
<td>358</td>
<td>.31</td>
<td>.60</td>
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<tr>
<td>High</td>
<td>0</td>
<td>2</td>
<td>87</td>
<td>.08</td>
<td>.29</td>
</tr>
</tbody>
</table>
Categories of Events

take off risk combinations
major risk detection on approach
approach risk combinations
approach risk combination
approach steady deviation
warning
thrust
height
acceleration
roll
vertical rates
pitch
configuration
alignment
take off
speed

Low
Medium
High
## Human Performance v. Aircraft Performance Measures

<table>
<thead>
<tr>
<th></th>
<th>N (flights)</th>
<th>Mean PVT</th>
<th>Mean exceedances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>204</td>
<td>212.02(29.72)</td>
<td>1.91(1.91)</td>
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<tr>
<td>Early duty</td>
<td>207</td>
<td>222.31(34.32)*</td>
<td>2.73(2.04)**</td>
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<tr>
<td>Mid duty</td>
<td>254</td>
<td>221.62(33.59)*</td>
<td>2.77(1.84)**</td>
</tr>
<tr>
<td>Late duty</td>
<td>139</td>
<td>227.48(35.16)**</td>
<td>2.71(2.10)*</td>
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</tbody>
</table>
# Exceedances by Type and Duty Schedule

<table>
<thead>
<tr>
<th></th>
<th>Severity Type</th>
<th>Overall</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Low</td>
</tr>
<tr>
<td>Baseline</td>
<td>143</td>
<td>1.73(1.78)</td>
</tr>
<tr>
<td>Early duty</td>
<td>196</td>
<td>2.31(1.79)**</td>
</tr>
<tr>
<td>Midday duty</td>
<td>238</td>
<td>2.44(1.56)*</td>
</tr>
<tr>
<td>Late duty</td>
<td>138</td>
<td>2.27(1.65)</td>
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</tbody>
</table>
Acknowledgements

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