Obstructive sleep apnoea and crash risk: Case study results within the development of the European road safety Decision Support System

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OSA and crash risk

- OSA (untreated) widely recognised as a crash risk in fatigue/sleep field.
- Road safety policy making fatigue can be overlooked.
  - Lack of understanding compared to other risks e.g. speeding, drink driving.
- Increasing prominence of evidence based policy making
  - Requires access and understanding of scientific literature
SafetyCube project

Safety Causation, Benefits and Efficiency (SafetyCube)
www.safetycube-project.eu

Funded by the European Commission under the Horizon 2020 research framework programme

Coordinator: Pete Thomas, Loughborough University

- Start: May 2015
- Finish: April 2018

17 partners from 12 EU countries
SafetyCube concept and vision

• There is rapid growth in knowledge about road safety risks and measures.
• It is an increasing challenge to effectively access this body of knowledge.
• The Road Safety DSS will provide easy access to a greater amount of knowledge than any existing policy support system.
The SafetyCube DSS objective is to provide a user friendly, web-based, interactive Decision Support System to properly substantiate road safety decisions for the actions, measures, programmes, policies and strategies to be implemented at local, regional, national, European and international level.

The main contents of the SafetyCube DSS concern:
• road accident risk factors
• road safety counter measures
• cost-benefit evaluation
• all related analytic background
• linking road safety problems with related countermeasures.
Current Road Safety DSS Worldwide

- Crash Modification Factors Clearinghouse (www.cmfclearinghouse.org) by NHTSA (USA) - **5.151 CMF** on infrastructure only - on going

- Road Safety Engineering Kit (www.engtoolkit.com.au) by Austroads (Australia) - **67 treatments** on infrastructure only

- PRACT Repository (www.pract-repository.eu) by CEDR (Europe) - **889 CMF** and **273 APM** on infrastructure only – high quality

- iRAP toolkit (toolkit.irap.org/) by iRAP - **58 treatments** (43 on infrastructure)

- Safety Performance Factors Clearinghouse (spfclearinghouse.org) by Tatum Group LLC, Dr. Andrew Kwasniak (USA) - **few SPF** – subscribers only
What is a risk factor?

- Any factor that contributes to the occurrence or the consequence of road accidents.
- Direct influence on the risk of an accident
  OR
- Indirect influence by a Safety Performance Indicator.
Co-ordinated methodology

- The Safe System: Road User behaviour, Infrastructure, Vehicles, Injury prevention.
  - Common methodological approach
- Taxonomy of risks and measures
  - Comprehensive
  - Inter-linked
- Coding studies for a back end database
- Drafting synopses summarising findings
Relational Data Base

- Flexible coding template to treat all studies with the same method.

- The templates of **coded studies** undergo a thorough checking and debugging process.

- The templates are eventually stored in a **relational database**, which serves as the back-end of the DSS.

- Front-end DSS results are retrieved through **queries** on the back-end database (DSS search engine).
Road user behaviour risks taxonomy

- 25 considered risk factors
- Fatigue is one
Case study – Obstructive Sleep Apnoea

- Taxonomy location
  - road user behaviour – risks

<table>
<thead>
<tr>
<th>Topic</th>
<th>Subtopic</th>
<th>Specific Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatigue</td>
<td>Not enough sleep</td>
<td>Not enough sleep</td>
</tr>
<tr>
<td></td>
<td>Driven a long time</td>
<td>Sleep disorders - OSA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Driven a long time</td>
</tr>
</tbody>
</table>
Method

- Literature search
- Prioritising studies for coding
- Coding
- Meta-analysis (if possible)
- Synopsis writing following standard guidelines
Obstructive Sleep Apnoea - outcome

COLOUR CODE: RED

• Studies consistently show that untreated Obstructive Sleep Apnoea is associated with increased risk for road traffic accidents.
### Literature search

**Database:** Scopus  
**Date:** 3 May 2016

<table>
<thead>
<tr>
<th>search no.</th>
<th>search terms / operators / combined queries</th>
<th>hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>“fatigue*” OR “sleep*” OR “tired*” OR “drowsy” OR “drowsiness” OR “alert*” OR “monoton*” OR “time on task” OR “mental* fatigue*” OR “mental* tired*”</td>
<td>393,733</td>
</tr>
<tr>
<td>#2</td>
<td>“Sleep disorde*” OR “Narcolepsy” OR “Apnea*” OR “Apnea” OR “Sleep disordered breathing” OR “OSA”</td>
<td>72,103</td>
</tr>
<tr>
<td>#3</td>
<td>“road safety” OR “traffic safety” OR “drive*” OR “road” OR “transport” OR “traffic” OR “Pedestrian” OR “Rider”</td>
<td>1,586,152</td>
</tr>
<tr>
<td>#4</td>
<td>“collision*” OR “crash*” OR “accident*” OR “incident*” OR “Road casualt*” OR “Road fatalt*” OR “injur*”</td>
<td>1,164,241</td>
</tr>
<tr>
<td>#5</td>
<td>“risk*” OR “severit*” OR “frequenc*”</td>
<td>3,472,721</td>
</tr>
<tr>
<td>#6</td>
<td>#1 OR #2</td>
<td>405,751</td>
</tr>
<tr>
<td>#7</td>
<td>#6 AND #3 AND #4 AND #5</td>
<td>1,682</td>
</tr>
</tbody>
</table>

- **English**
- **Title – ABS-Key**
- 1 Jan 2006 – 3 May 2016
- Europe, Israel, North America, Australia, New Zealand and Japan

= 997 hits
Screening

1. First pass title and abstract relevance screening, de-duplication, = 159 remaining studies
2. Removal of those without codable data (quantifiable effect size of influence on crashes: review/commentary/no quantitative data/no control group removed), identification of meta-analysis, separation by topic = 20 OSA studies
3. Full text obtained for 18 OSA studies
Prioritisation

1. Meta-analysis;
2. Studies examining crash risk for truck drivers published after the meta analysis literature search date;
3. Studies examining crash risk for general driving population published after the meta analysis literature search date;
4. Simulator studies.
Final coded studies


Individual study results in DSS

Title, author, source, abstract
- Link to URL for full-text download (depending on Institute permissions)

Study design info
- Country
- Research Method, Design, Sample N
- Control group, Risk Group
- Modifying Conditions

Study results:
- Table listing the effects reported in the study
- Table columns concern main study / effect characteristics (outcome variable, effect type, size and confidence intervals, statistical significance)
Synopsis

• Summary (2 pages, lay language)
  – Abstract
  – Background – How is it defined? How is it measured? Etc
  – Overview of results

• Scientific overview
  – Detailed review of considered studies methodologies
  – Review of study effects on road safety

• Supporting Document
  – Literature search process
  – Additional details about reviewed studies
## Road user behaviour risk overview

<table>
<thead>
<tr>
<th>Risky</th>
<th>Probably risky</th>
<th>Unclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenced driving – alcohol</td>
<td>Risk taking – overtaking</td>
<td>Functional impairment – hearing loss (few studies)</td>
</tr>
<tr>
<td>Influenced Driving – drugs</td>
<td>Risk taking – close following behaviour</td>
<td>Observation errors (few studies)</td>
</tr>
<tr>
<td>(legal &amp; illegal)</td>
<td>Insufficient knowledge and skills</td>
<td>Distraction – music – entertainment systems (many</td>
</tr>
<tr>
<td>Speeding and inappropriate</td>
<td>Functional impairment – functional impairment</td>
<td>studies, mixed results)</td>
</tr>
<tr>
<td>speed</td>
<td>Functional impairment – cognitive impairment</td>
<td>Distraction – operating devices (many studies, mixed</td>
</tr>
<tr>
<td>Traffic rule violations</td>
<td>Functional impairment – vision loss</td>
<td>results)</td>
</tr>
<tr>
<td></td>
<td>Diseases and disorders – diabetes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Personal factors – sensation seeking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Personal factors – ADHD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emotions – anger, aggression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatigue – Not enough sleep/driving while tired</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distraction – conversation with passengers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distraction – outside of vehicle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distraction – cognitive overload and inattention</td>
<td></td>
</tr>
<tr>
<td>Fatigue – sleep disorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sleep apnea</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Strengths

• Comprehensive summaries of existing knowledge accessible to policy makers and practitioners.
  – Road user behaviour, infrastructure, vehicles
• Standardised approach to coding scientific literature.
• Ranking of risks factors.
• Effectiveness ranking of countermeasures.
• Detailed explanations of individual analysed study.
• Established system which can be expanded in the future.
Limitations

• Need for codable data to apply a common methodology.
• Many studies of risk factors focus on conditions of behaviour (situations under which a behaviour is shown, or which groups are more likely to experience this risk) these cannot be directly related to crashes.
• Broad topic range necessitated restriction of individual scope – OSA is the only sleep disorder considered in the DSS.
Road Safety DSS Development

Next steps

- **DSS web interface Development phase**
  - *between November 2016 and May 2017*
  - *So far including all risk factors (~3,500 effects from 600 studies) and several measures*
  - *Measures analysis on going (completed by June)*

- **DSS testing phase**
  - *Will be ready in August 2016*

- **DSS opening**
  - *September 2017*

- **Continuous Enhancement and Update**
  - *Starting on September 2017 and will be updated to April 2018 (end of SafetyCube project) onwards*
Conclusion

• Custodians of road safety budgets need a broad understanding of all crash risks to appropriately allocate funds.
• There is a need to increase understanding of OSA by policy makers
  — Demonstrated by inter-country inconsistency on OSA related road safety policy
• The approach taken in discipline specific research is not always the most relevant for policy makers – real world crash focused
• DSS provides a go-between tool to give policy makers an overview of a problem
Thank you

Questions?

www.SafetyCube-project.eu

www.RoadSafety-dss.eu

Opening: September 2017

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