WELCOME

Following the Science: Evidence-based Approaches to Improving Patient & Provider Safety
Today

- Lights and Siren
  - Literature review and best practices
  - Use and usefulness
- Fatigue in EMS
  - Systematic review of the evidence
  - Evidence-based guidelines and recommendations

Today’s Speakers

- Douglas Kupas, MD, EMT-P, FAEMS, Professor of Emergency Medicine, EMS Medical Director
  - Geisinger Health
  - Pennsylvania Department of Health
- P. Daniel Patterson, PhD, NRP, Assistant Professor of Emergency Medicine
  - University of Pittsburgh
- Dave Bryson, EMT, EMS Specialist
  - NHTSA Office of EMS
Lights & Siren Use by EMS: Above All, Do No Harm

Douglas F. Kupas, MD, EMT-P, FAEMS

EMS Focus
RLS-related EMVCs

- Most at intersections
- Increased incidence of injury
- Nearly all severe injuries unrestrained

Literature Review

- Literature based (peer and non-peer reviewed)
Annotated Bibliography

- EMS vehicle crash statistics, driving (including driver training), liability, and ethics (55)
- Effectiveness of warning L&S (and vehicle conspicuity) (33)
- Time savings with L&S response and transport (24)
- Traffic signal preemption systems (3)
- Public perception and expectations related to L&S use (8)

Total references = 202 references / 9 sections
Reasons for L&S

- “Saves time”
- Contract requirements (< 8 minutes)
- Medical emergency
- Public expectations
- Fun/EMS provider retention, “they’ll quit”
- Insurance requirements

1. Introduction – primum non nocere

- L&S use is a medical intervention

Lights and Siren
Sig: Dispense one L&S transport, Use only when indicated
2. Current Use of L&S in U.S.

- 15.7 million 911 responses with transport
  - Response: 76.5% used L&S
    - No change from 2010 to 2015
  - Transport: 22.7% used L&S (73.3% did not)
    - 10.9 decrease in use since 2010
    - Varies 10.3% by urbanicity
    - Varies by 20.8% across U.S. Census divisions
    - 58% L&S transport in PA in 1991
3. Review of State Laws Regarding L&S Use by EMS

- Uniform Vehicle Code
  - Proceed through a red traffic signal, stop light/sign
    - Some states require full stop - Recommended
  - Drive wrong way opposing traffic
  - Exceed posted speed limit
    - Some states limit speed – Recommended
  - Park where otherwise not legal
4. Discussion

- Use and usefulness of emergency warning lights and vehicle conspicuity
- Use and usefulness of sirens
- Time saved with L&S
- Association between L&S driving and crash risk
- Traffic signal preemption devices
- Hazards of L&S use for EMS providers
- EMS and L&S response
- Clinical considerations related to L&S use during transport
- Public perceptions and expectations for L&S use
- Recommendations for EMS vehicle operations policies

Discussion – Use and usefulness of emergency warning lights and vehicle conspicuity

- Warning Lights
- Retroreflective Material
- Vehicle Color
Retroflective Material
Emergency Warning Lights Requesting the Right of Way

Emergency Warning Lights Blocking the Right of Way
Emergency Warning Lights Blocking the Right of Way

Discussion – Use and usefulness of sirens

Rural
(55 mph, closed window, radio on)

<table>
<thead>
<tr>
<th>Siren Type</th>
<th>Straight</th>
<th>Crossroad</th>
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</thead>
<tbody>
<tr>
<td>Electronic wail</td>
<td>33 ft.</td>
<td>14 ft.</td>
</tr>
<tr>
<td>Electronic yelp</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
<td>Electronic hi-lo</td>
<td>24</td>
<td>&lt;12</td>
</tr>
<tr>
<td>Mechanical wail</td>
<td>33</td>
<td>&lt;12</td>
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</table>
**Discussion – Time saved with L&S**

(response)

### TABLE M

Mean response time interval differences related to L&S use
(from seven studies as shown)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year of Study</th>
<th>Community/Geographical Location</th>
<th>Time Saved (in minutes)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dhindsa</td>
<td>1994</td>
<td>Washington, DC</td>
<td>3.6</td>
<td>Poster Abstract</td>
</tr>
<tr>
<td>Zachariah</td>
<td>1994</td>
<td>Suburban Texas</td>
<td>1.7</td>
<td>Poster Abstract</td>
</tr>
<tr>
<td>Ho</td>
<td>1998</td>
<td>Minneapolis, MN</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>2000</td>
<td>Syracuse, NY</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Ho</td>
<td>2001</td>
<td>Becker County, MN (rural)</td>
<td>3.6</td>
<td>Fire Department Report</td>
</tr>
<tr>
<td>Williams</td>
<td>2006</td>
<td>Anne Arundel County, MD</td>
<td>2.2</td>
<td>Response to Stroke</td>
</tr>
<tr>
<td>Yeh</td>
<td>2011</td>
<td>San Francisco, CA</td>
<td>1.9</td>
<td>Symptoms</td>
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</tbody>
</table>

**Discussion – Time saved with L&S**

(transport)

### TABLE N

Mean transport time interval differences related to L&S use
(from eight studies as shown)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year of Study</th>
<th>Community/Geographical Location</th>
<th>Time Saved (in minutes)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dhindsa</td>
<td>1994</td>
<td>Washington, DC</td>
<td>3.0</td>
<td>Poster Abstract</td>
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<tr>
<td>Hunt</td>
<td>1995</td>
<td>Greenville, NC</td>
<td>0.7</td>
<td></td>
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<tr>
<td>O’Brien</td>
<td>1999</td>
<td>Jefferson County, KY</td>
<td>3.5</td>
<td>Reviewed critical interventions at hospital</td>
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<tr>
<td>Brown</td>
<td>2000</td>
<td>Syracuse, NY</td>
<td>1.8</td>
<td>Up to 10.2 minutes for areas farther from hospital</td>
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<tr>
<td>Williams</td>
<td>2005</td>
<td>Anne Arundel County, MD</td>
<td>2.4</td>
<td>GPS/Google maps</td>
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<tr>
<td>Marques-Baptista</td>
<td>2010</td>
<td>New Brunswick, NJ</td>
<td>2.6</td>
<td>Reviewed critical interventions at hospital</td>
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<tr>
<td>Fleischman</td>
<td>2013</td>
<td>Multnomah County, OR</td>
<td>3.1</td>
<td>GPS/Google maps</td>
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<tr>
<td>Dami</td>
<td>2014</td>
<td>Vaud, Switzerland</td>
<td>1.8</td>
<td>No difference at night, 16.0% L&amp;S transport rate</td>
</tr>
</tbody>
</table>
Discussion – Hazards of L&S use for EMS providers

- Accelerated hearing loss
- Off-balance injuries in patient compartment

Discussion – Clinical considerations related to L&S use during transport

- Kupas DF, Dula DJ, Pino Bj. PDM. 1994
  - 130/162 (8%) Emergent
  - 1495/1625 (92%) Nonemergent

![Patient Condition During Transport Diagram]

- Jackson Mem. Hosp – 808 patients
  - 67.1% not admitted
  - “87.8% of patients arriving by ambulance need not have been rushed to the hospital.”
- Duval Med. Center – 378 patients
  - “Conservatively 15% of admitted patients and 4.2% of all patients are true emergencies.”
- 1951 – 25 ambulance crashes in FL
  - 1 fatality, 14 injuries
Discussion
Public perceptions and expectations for L&S use

“Competence is more often shown by quiet deliberateness than by noisy bravado.”

E. Marie Wilson
Conn. EMS Patient Survey
1980

Connecticut EMS Patient Survey 1980

- Public's Reasons for EMS Uneasiness
  - Sirens and noise
  - Getting a lot of attention
  - Abilities of crew
  - Dealing with strangers
Discussion: Recommendations for EMS vehicle operations policies

- L&S use is a medical intervention
- Performance Parameter Benchmarks
  - L&S Response < 50% of 911 responses
  - L&S Transport < 5% of 911 responses
    - L&S transport could be a sentinel QI event
- EMSVO training, continuing education, policies
- Requesting vs. blocking “right of way”
- EMD
- Medical direction
- EMS seatbelt use / vehicle design
Evidence-based Guidelines For Fatigue Risk Management in Emergency Medical Services

Daniel Patterson, PhD, NRP

South Dakota Ambulance Flips After Driver Falls Asleep

State Coroner: fatigue a factor in administering wrong drug

- In 2007 Coroner Peter White reported that while attempting to resuscitate a 78-year-old male cardiac patient, a paramedic accidentally administered morphine instead of adrenalin.
- The Coroner said fatigue was a factor. "I am satisfied that both officers were affected by fatigue at the time of these incidents and that resulting error was almost a certainty in such circumstances."
- A police officer was unqualified but "the possibility that reanimation may have been more effective given appropriate treatment cannot be excluded."

Second ambulance crash in three days

Rachel McGuire, WCN

BOWDOINHAM, Maine (NEWS CENTER) — A nurse was injured when a Delta Ambulance swerved into a median, went airborne, and struck a guardrail early Friday morning, according to Maine State Police.
The NHTSA Fatigue in EMS Project

- Aim 1: To develop evidence-based guidelines for fatigue risk management in Emergency Medical Services

Methods

- We completed seven systematic reviews guided by seven research questions (PMID-27858581)
- Reviewed literature from 1980 to September 2016
- Used the Grading of Recommendations, Assessment, Development and Evaluation methodology
## Results

<table>
<thead>
<tr>
<th>Systematic Review</th>
<th>Literature Screened/Reviewed</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1,257</td>
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<tr>
<td>2</td>
<td>21,670</td>
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<td>3</td>
<td>1,401</td>
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<td>4</td>
<td>4,656</td>
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<tr>
<td>5</td>
<td>3,817</td>
</tr>
<tr>
<td>6</td>
<td>2,777</td>
</tr>
<tr>
<td>7</td>
<td>3,394</td>
</tr>
<tr>
<td>TOTAL</td>
<td>38,972</td>
</tr>
</tbody>
</table>
In EMS personnel, do task load interventions mitigate fatigue, mitigate fatigue-related risks, and/or improve sleep?

PROSPERO 2016:CRD42016040114
Systematic Review #7

- No recommendation: The confidence in effect estimates is insufficient to make a recommendation at this time.

(GRADE Handbook 6.1.4)

Systematic Review #6

- In EMS personnel, does implementation of model-based fatigue risk management mitigate fatigue, mitigate fatigue-related risks, and/or improve sleep?

- PROSPERO 2016:CRD42016040112
No recommendation: The confidence in effect estimates is insufficient to make a recommendation at this time.

(GRADE Handbook 6.1.4)
Systematic Review #5

- In EMS personnel, does fatigue training and education mitigate fatigue, mitigate fatigue-related risks, and/or improve sleep?

- PROSPERO 2016:CRD42016040110
We recommend that EMS personnel receive education and training to mitigate fatigue and fatigue-related risks (weak recommendation in favor, low certainty in evidence).

Systematic Review #4

In EMS personnel, does the use of sleep or rest strategies and/or interventions mitigate fatigue, mitigate fatigue-related risks, and/or improve sleep?

PROSPERO 2016:CRD42016040107
Systematic Review #4

- We recommend that EMS personnel have the opportunity to nap while on duty to mitigate fatigue (weak recommendation in favor, very low certainty in effect).
Systematic Review #3

- In EMS personnel, does the worker’s use of fatigue countermeasures mitigate fatigue, fatigue-related risks, and/or improve sleep?

- PROSPERO 2016:CRD420106040101
Systematic Review #3

- We recommend that EMS workers have access to caffeine as a fatigue countermeasure (weak recommendation in favor, low certainty in effect).

Systematic Review #2

- In EMS personnel, do shift-rescheduling interventions mitigate fatigue, mitigate fatigue-related risks, and/or improve sleep?

  PROSPERO 2016:CRD42016040099
Systematic Review #2

- We recommend that EMS personnel work shifts shorter than 24 hours in duration (weak recommendation in favor, very low certainty in effect).
  - The panel does not have a recommendation regarding 8hr vs. 12hr shifts or other shift comparisons that are less than 24 hours.
Systematic Review #1

- Are there reliable and valid instruments for measuring fatigue among EMS personnel?

- PROSPERO 2016:CRD42016040097
We recommend using fatigue/sleepiness survey instruments to measure and monitor fatigue in EMS personnel (strong recommendation, very low certainty in evidence).

Next Steps

- **PHASE 1**: Develop Evidence-Based Guideline (EBG) for fatigue risk management in EMS
- **PHASE 2**: Test the impact of one or more evidence-based recommendations in an experimental study
- **PHASE 3**: Develop a biostatistical model tailored to EMS shift scheduling and make freely available
Significance of the EMS Fatigue Project

1. Local leaders have a starting point from which to build a fatigue risk management program – based on evidence.

2. State, regional, national organizations have a template, frame of reference, a resource to help local agencies.

3. Individual clinicians have a resource to point to if your organization does not, or is not actively addressing fatigue in the EMS workplace.

Phase 1 Dissemination

- Journal publications in PEC
- Guidebook on Fatigue Management in EMS
- Presentations
- 1-pager handout
- Interviews
- Commentaries/Editorials in trade journals
- Other
Q&A