Impairment Related to Blood Amphetamine Concentration in Drivers Suspected of Drug Abuse

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Background
Driving under the influence of amphetamine constitutes a risk to traffic safety (1-3). It has been difficult, however, to demonstrate psychomotor impairment in a laboratory setting for this drug (4). It has therefore been speculated that a probable increased accident risk is due to phenomena like risk taking (3) and fatigue as a consequence of drug withdrawal (2;5).

In laboratory settings, when examining amphetamine’s influence on psychomotor performance, modest doses (5-15 mg ingested orally) are often used (1;2). In a naturalistic setting the amphetamine is often injected intravenously and the dose is often much higher, up to 50-300 mg or more. Furthermore, amphetamine is often taken in binges. During this high-dose, chronic or binge amphetamine use the relationship between concentration and effect is not known.

Only a few studies on stimulants and impairment in a naturalistic setting include measurements of blood drug concentrations (3). Most studies do not describe blood amphetamine concentrations at all. One study measured metamphetamine concentrations in apprehended drivers and concluded that any drug concentration was inconsistent with safe driving (5).

Objectives
In the present study we wanted to investigate whether impairment as measured by the Norwegian Clinical Test for Impairment (CTI) related to blood amphetamine concentrations in drivers suspected of drugged driving.

Methodology
All the present data were taken from the register at The Norwegian Institute of Public Health, Division of Forensic Toxicology and Drug abuse. The register contains information from all the drivers suspected of driving under the influence of alcohol and non-alcohol drugs in Norway. The data were handled anonymously.

In all the cases of suspected drugged driving in Norway, a police physician will draw a blood sample and perform the Clinical Test for Impairment (CTI) shortly after apprehension. The CTI ends with a conclusion on the driver being not impaired or impaired.

The institute analyses approximately 5000 blood samples from suspected drugged drivers each year. During the later years approximately 30% of the blood samples have contained amphetamines. The present material included the blood samples containing amphetamine as only drug. A minor number of the cases contained metamphetamine as well. From December 2000 till January 2004, a total of 1071 cases were found. In 878
cases the physician reached a conclusion concerning impairment. These cases constituted our material.

All blood samples from suspected drivers were routinely screened for alcohol and common drugs of abuse (amphetamines, benzodiazepines, cannabis, cocaine and opiates). Results were confirmed and concentration measured by gas chromatography - mass spectrometry analysis (GC-MS) (6). The cases were divided into five groups according to their range of amphetamine concentrations.

The data analyses were performed by the use of Statistical Package for Social Sciences (SPSS) version 11.0. Differences between two groups were examined by the use of \( \chi^2 \) – tests or Student-T-tests. Correlation between variables was tested using Spearman’s \( \rho \). A binary logistic regression model was used to determine odds ratios (ORs) and their 95% confidence intervals (CI). Levels of significance for all analysis were set to \( P < 0.05 \) or \( P < 0.01 \).

Figure 1
The percentage of suspected drugged drivers determined impaired related to blood amphetamine concentrations. The number of drivers in each group is indicated at the columns

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>162</td>
<td>239</td>
<td>254</td>
<td>175</td>
</tr>
</tbody>
</table>

Results and analysis
The material consisted of 878 suspected drivers. 786 (90%) of the drivers were male. The suspected drivers were from 17 to 60 years of age with mean age of 31.2 years (7.6 years).

691 (79%) cases contained amphetamine alone and 31 (4%) cases contained metamphetamine alone. The remaining 156 cases (18%) contained both drugs. The sum of amphetamines is in the following referred to as blood amphetamine concentrations. The median blood amphetamine concentration for all the cases was 0.52 mg/L (0.04 - 3.74 mg/L).
235 (27%) of the suspected drivers were judged as not impaired, while 643 (73%) were judged as impaired. Moving from one blood amphetamine concentration group to the next, an increasing percentage of the drivers were judged impaired (figure 1). Above the blood amphetamine concentration in group 3 (0.27 - 0.53 mg/L) there was no increase in this percentage.

Using group 1 as reference group (OR = 1), the OR for being judged impaired was elevated in all other groups (table 1). This relationship withstood adjustment for age and sex.

| Table 1 |
| A binary regression model for the relationship between blood amphetamine concentration and being judged impaired by the police physician. OR with 95% CI is given. The lowest concentration group is used as reference category (OR=1). The blood drug concentrations included in each group is noted below the group number |

<table>
<thead>
<tr>
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<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04-0.10 mg/L</td>
<td>0.11-0.26 mg/L</td>
<td>0.27-0.53 mg/L</td>
<td>0.54-1.00 mg/L</td>
<td>&gt;1.00 mg/L</td>
</tr>
<tr>
<td>Amphetamine</td>
<td>1</td>
<td>1.56</td>
<td>2.57</td>
<td>1.99</td>
</tr>
<tr>
<td>Adjusted age and sex</td>
<td>1</td>
<td>(0.80-3.02)</td>
<td>(1.34-4.93)b</td>
<td>(1.05-3.77)c</td>
</tr>
<tr>
<td>Adjusted age and sex</td>
<td>1</td>
<td>1.60</td>
<td>2.64</td>
<td>2.15</td>
</tr>
<tr>
<td>Adjusted age and sex</td>
<td>1</td>
<td>(0.82-3.13)</td>
<td>(1.37-5.09)b</td>
<td>(1.12-4.10)c</td>
</tr>
</tbody>
</table>

| aReference group |
| bP < 0.01 |
| cP < 0.05 |

**Discussion**

The present study showed a relation between blood amphetamine concentration and clinical impairment as assessed by the CTI. This relation reached a “ceiling effect” above the blood amphetamine level of 0.27 mg/L – 0.53 mg/L.

The present included a wide range of blood amphetamine concentrations from a real-life, naturalistic setting. We had, however, no information about the time of drug intake, dose ingested, earlier and present pattern of use, or the route of administration. Furthermore we have little knowledge about the reliability of the CTI as a measurement of clinical impairment due to amphetamines. Our research group have earlier described concentration-effect relationships between the blood drug concentration of benzodiazepines (7) and opiates (8) and impairment as measured at the CTI, indicating that the CTI can be used for measuring impairment in suspects of drugged driving. We have little knowledge of the relationship between the impairment as measured by the CTI and traffic risk.

Earlier research has failed to find a relationship between blood amphetamine concentration and impairment (3;9;10), while other studies have described concentration-effect relationships (11). The CTI was originally designed to investigate impairment due to alcohol and probably detects impairment due to sedation more easily than impairment due to centrally stimulating effects. However, amphetamine is often abused in binges that end with excessive exhaustion if no further administration of amphetamine is undertaken.
Higher blood stimulant concentrations will produce more dramatic exhaustion, or impairing effects, during the elimination phase than lower concentrations (5). We could be examining “end-binge” phenomena in the present study.

**Conclusion**

The present study showed a relation between blood amphetamine concentration and clinical impairment as assessed by the CTI.

**Possible next steps**

The study of these questions will in the future be addressed by looking at the different tests and observations of the CTI.

**Reference List**