Vehicle Technologies to Prevent Crashes Involving Alcohol-Impaired Drivers

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J.K. Pollard, Eric Nadler, Mary Stearns, Steve Popkin
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Outline of Presentation

- Current Technologies
- Technologies under Development
  - Advantages and Limitations
- Crosscutting Issues
- Concept of Operations
- Conclusions and Recommendations

Objectives

- Review focused on domestic and international alcohol detection
- Determine research needs for possible alcohol detection
- Develop a concept of operations for an in-vehicle system addressing alcohol impairments

Approach

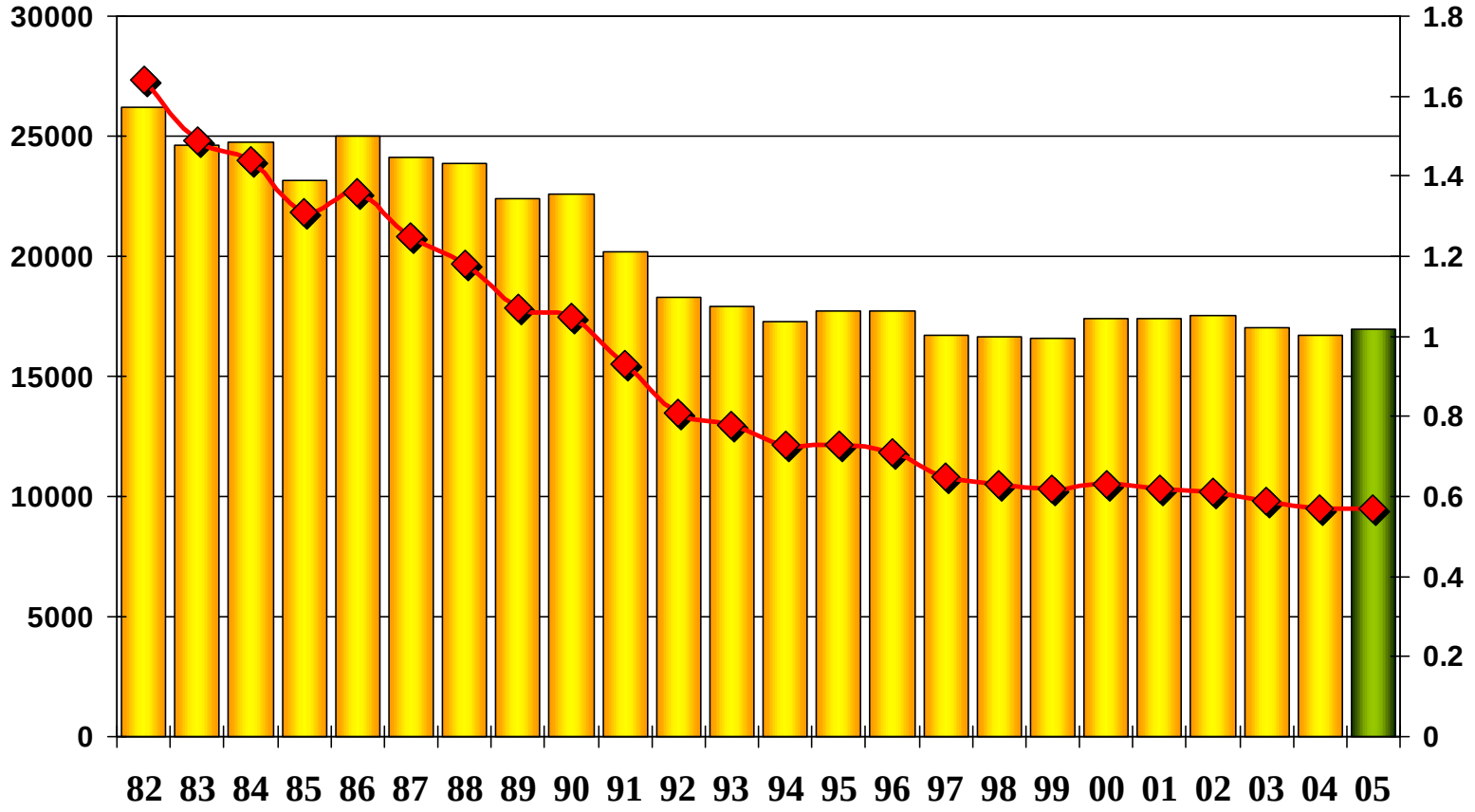
- Identify and interview ~60 stakeholders regarding various technologies including accuracy, costs, problems, prospects for improvement, etc.
- Review literature for same
- Understand strengths and weaknesses of alternative impairment-detection technologies
- Some proprietary technologies excluded

Glossary

- BAIID – Breath Alcohol Ignition Interlock Device
- NIR – Near Infrared (portion of spectrum where ethanol has prominent absorption peaks
- fNIR – Functional NIR – images hemodynamic changes in brain; shows which areas are active
- TOPIC – Technology to Prevent Alcohol -Impaired Crashes
- Primary interlock – one applicable to all drivers, probably installed as factory equipment
- Secondary interlock – one used as a consequence of a DUI offence

Alcohol-Related Fatalities & Rate (per 100M VMT)

1982-2005



Potential for Crash Reduction

- In 2004:
  - 1.014M DUI arrests, 0.5% of licensed drivers
  - 1/3 repeat offenders
  - 16,694 alcohol-related fatalities
  - 14,409 persons killed in accidents where someone had BAC=.08+, but only 10,381 were drunk drivers of cars or light trucks
  - 615,271 alcohol-related crashes

Technology in Use

- BAIIDs (secondary, i.e., for offenders)
  - Effective in reducing DUI recidivism while installed
  - Require periodic visits to service center (monthly) for data download, sensor replacement/recalibration, and circumvention prevention
  - Have virtually no voluntary users in USA
  - Are applied to about one-third of repeat offenders (which is less than 8% of all DUIs)
  - Use increasing
  - While used, make crash rates of DUI offenders equivalent to those of other drivers

Limitations of BAIIDs

- High maintenance
  - Sensors vulnerable to contamination, which causes erroneous readings, usually too low
  - Monthly test/recalibration/replacement
- Easily bypassed; data must be checked frequently to prevent this
- High cost – about $900 per year
- Requires substantial administrative infrastructure to enforce maintenance and prevent circumvention

European Experiments with Primary BAIIDs

- Small-scale experiments in 5 EU nations – mostly with commercial fleets (Belgium, Germany, Netherlands, Norway, & Spain)
- More widespread testing in Sweden
  - Proposed legislation making interlocks mandatory in commercial vehicles in 2010 and all vehicles in 2012
  - 80% of new car sales to fleet buyers
  - Saab & Volvo have announced plans to offer interlocks as options: about $300, about 2009
  - Reports of technical difficulties and bypassing

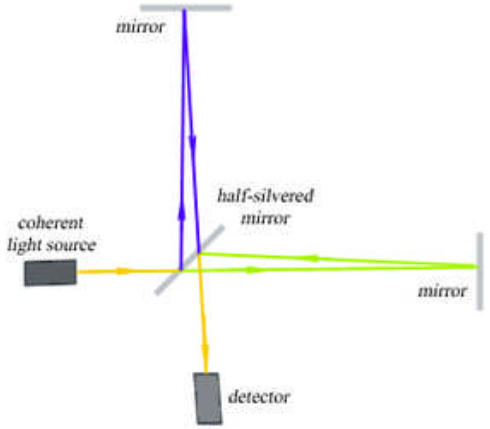
Technologies under Development

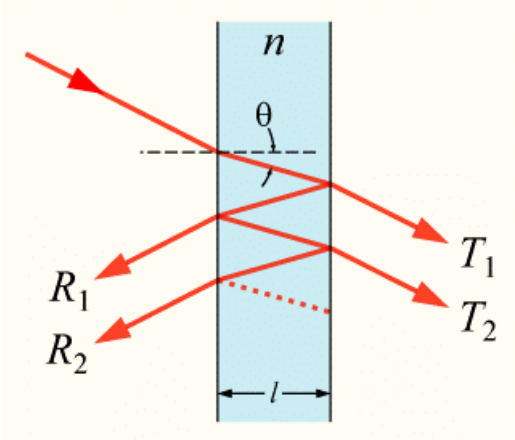
- Tissue Spectroscopy
- Ethanol Vapor Detectors
  - Transdermal (body-worn)
  - Environmental (vehicle mount)
- Ocular Measures

Tissue Spectroscopy

- Exists only as a prototype for clinical use
- Superior accuracy & specificity
- Fewer inherent problems than other approaches
- Not yet established that it can work on hand
- Requires large reduction in size and cost to be viable

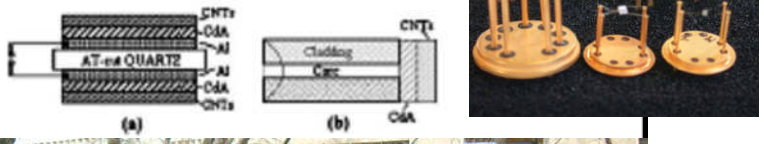
Alternative Implementations of Tissue Spectroscopy

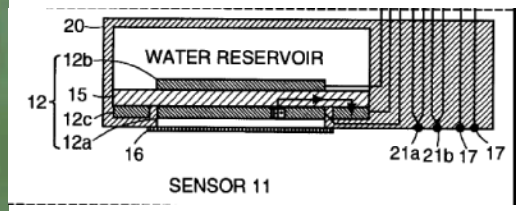




- Michelson (TruTouch)
- Fabry-Perot (Univ. of Alberta)
- TDLS (tunable-diode laser spectroscopy)
- Multiple discreet LEDs --(Lumidigm), possibly quantum-dot-LEDs

Ethanol Vapor Sensors – Worldwide Interest



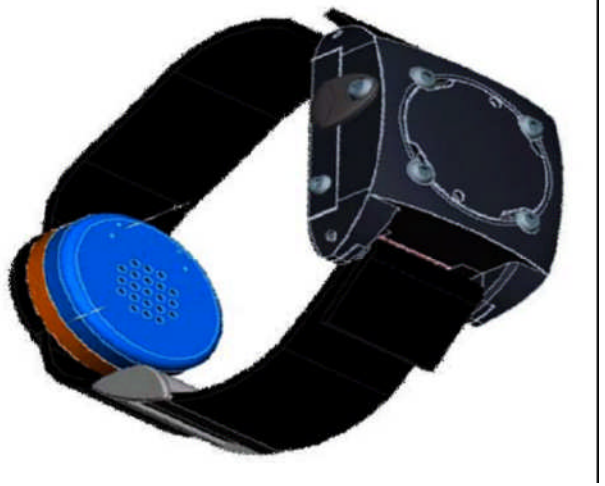


- Italy: Optical and acoustic sensors using carbon nanotubes
- Russia: Tunable diode laser spectroscopy (whole vehicle)
- Sweden: Gallium arsenide doped semiconductor
- Vietnam: low-cost, solid-state detectors using nanosize perovskite crystals
- USA: solid polymer electrolyte detectors

Transdermal Detectors

- SCRAM-Secure Continuous Remote Alcohol Monitor
- Commercially available
- Several thousand in use under court mandates
- $10-12 per day
- Fuel cell

- WrisTAS –solid polymer detector under development by Giner
- Potentially smaller, cheaper, & lower powered than fuel cell



Environmental Vapor Detector Application

- Vehicle-mounted detection systems that send short-range signals to police identifying vehicles (license plate and description) with ethanol vapor present, so that these drivers may be stopped and tested
- If successful, could improve effectiveness of checkpoints
- But seems vulnerable to easy circumvention
- Contamination problem – catalyst poisoning

Useful Ocular Measures

FIT-2000-Mobile
Pupilometry and saccadic velocity
750 measurements per second
19 pounds

- Horizontal gaze nystagmus – accepted element of Field Sobriety Test, but difficult and expensive to automate
- Pupilometry – known devices are large and expensive. Eyes must be shielded from ambient light to obtain valid results.

Comparison Matrix for Primary-Interlock Applications

	Criteria					
Technologies	**Accuracy (sensitivity)**	**Cost (per unit)**	**Development Time**	**Convenience**	**Circumvention Risk**	**Technical Risk**
Tissue Spectroscopy	+++	?	__	+++	+++	--
BAIID	++	+	+++	-	++	++
Transdermal	+	-	+	-	+++	+
Environmental Vapor	--	++	+	+++	---	+++
Ocular	+	---	++	--	--	+

Scale: +++ Best to ---Worst

Crosscutting Implementation Issues

- Privacy
- Circumvention
- Active versus Passive
- Detection Set Point
- Target Populations
- Financial Incentives

Privacy

A technology that simply prevents impaired driving without involving authorities in any way and no data is collected.

Circumvention

- All TOPIC approaches are somewhat vulnerable to circumvention.
- BAIIDs require monthly visits to service centers. Centers collect a fee (usually $50 – $75) when a circumvention is detected.

Active versus Passive

- Passive testing for impairment (little or no special actions required of driver) is preferred. Going through some test procedure every time you start your car is viewed as a showstopper by most observers.
- But virtually every technology is more accurate -- sometimes much more accurate -- when used in a procedure that requires the active participation of the driver.
- Improvements in technology may eventually offset the advantage of active methods, but this can add many years to development time.

Detection Set Point

- “Threshold” of detection is arbitrary for all technologies. “Sensitivity” is the inherent quality of a detector to discriminate between presence and absence of signal.
- Per se limit offers much wider consumer acceptance than zero-tolerance and is what auto industry assumes

Early Target Populations for Primary Interlocks

- Fleet vehicles
  - will aid in resolution of early reliability problems and minimize adverse effects on the public
  - tend to have high safety sensitivity because they are typically early-adopters of new safety technology
    - Passenger carriers
    - Hazmat carriers
- Parents of teenage drivers – because their anxiety makes them good prospects

Financial Incentives

- Most potential buyers (those who never drink to excess) won't opt for it without a financial incentive: insurance discount (or surcharge for non-buyers) or tax credit.
- Insured losses for alcohol-related crashes are estimated at $284 per vehicle per year in 2006. Sets upper bound for discount.
- Fallacy: These buyers would not cause alcohol-related crashes in the first place.

Concept of Operations

- Tissue spectroscopy device embedded in steering wheel or key fob prevents engine start if BAC > per se limit
- Circumvention prevention thru: identification of user and secure integration with engine-control computer. No data reporting.
- High technical risk. Must have orders of magnitude improvement in size, cost, ruggedness and reliability

Conclusions

- No near-term TOPIC for primary interlock
- Tissue spectroscopy has potential for best accuracy in combination with user convenience
- All approaches subject to circumvention
- Government participation will be required
  - to aid in the development of these technologies
  - for potential large-scale testing

Research Recommendations

- Start the evolution of technology by developing and field testing an evidential tissue-spectroscopy device
- Determine whether spectroscopy can be applied to palms and fingers
- Determine which implementation of TS is optimal (Michelson, MEMS/Fabry-Perot, TDLS, QDOT)
- Monitor developments in Sweden