Studies on User Acceptability of Alcohol Ignition Interlock System and Notes when Using it *

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The operation load of alcohol ignition interlock system on driving was measured by various driving scenes. It has been afraid that measuring the expiration while driving might make the driver anxious. Moreover, a change with the lapse of time of an expiration alcoholic density after non-alcoholic food and drink had been taken was measured. As a result, it is necessary to note that the engine might not be able to be started to detect alcohol immediately after drivers take food and drink including alcohol.

Key Words: Alcohol, Usability, Ignition interlock system

1. Introduction

The concentration of alcohol in a driver’s breath (BrAC) as related to penal regulations for drunk driving (i.e., driving under the influence of alcohol) is addressed in the Road Traffic Law Enforcement Order. The BrAC level was amended to 0.15 mg/L(concentration in blood 0.30 mg/mL) in 2002 (formerly 0.25 mg/L in the breath and 0.5 mg/mL in blood). Furthermore, the penalties for drunk driving have been increased. Despite these amendments of the law, fatal accidents continue to occur as a result of drunk driving.

Devices to detect the BrAC include those used for safety management in carriers and for a crackdown on drunk drivers. In the United States, guidelines are provided for alcohol ignition interlock system (AILS) used for the purpose of penalizing drunk drivers. (1)

However, Japan has no standards for alcohol detectors. Therefore, the Ministry of Land, Infrastructure and Transport held a Study Meeting for Alcohol Interlock Devices in Jan. 2007, and established the "Draft technical guidelines for breath alcohol ignition interlock devices", (2) which they published in Dec. 2007. From now on, it is expected that the AILS used in Japan will be required to comply with these guidelines.

Therefore, this study was conducted to clarify the problems that may occur when AILS is mounted on vehicle.

2. Study on acceptability for users

2.1 Purpose

Foreign countries require that an AILS tests the driver’s BrAC even after the engine has started, to prevent illegal avoidance of tests with the use of a substitute.

The “Illegal Modification and Avoidance” section of the NHTSA Technical Standard indicates that the driver should undergo a second breath analyzer test within 5 to 30 min after starting the engine. Furthermore, it stipulates that operating the AILS should be as easy as operating an air conditioner or radio, and not require even a side glance when this second test is conducted. The CENELEC Technical Standard (3) of Europe also indicates that the AILS should require the driver to undergo a second test at random time intervals.

Although such a second test is considered necessary to prevent the illegal avoidance of tests, it is necessary to examine whether operating the AILS while driving impairs safety under the traffic conditions of Japan.

2.2 Test method

(1) AILS used for the test

An AILS that uses an electrochemical sensor was mounted on the test vehicle. Approximately 12,000 of these devices are exported to foreign countries (as of Aug. 2007), with the market share of 40% in Sweden.

(2) Test vehicles

A passenger car with an automatic transmission and a heavy truck with a manual transmission were used as test vehicles. The AILS was mounted on the left side of the driver’s seat (Fig.1, Fig.2).

(3) Measurement items

- Operation time and glance time

The driver’s eye movement was recorded by a CCD camera.

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mounted on the dashboard and a DV recorder. Glance time, number of glances, total glance time related to the operation of the AILS, and the total operating time were obtained by frame analysis of the recorded tape (30 frames/sec). The total operating time was defined as the time from the start of operation (when the hand was released from the steering wheel) to the end of operation (when the AILS was returned to the mounting position).

![Passenger car](Fig.1) Condition of the AILS installed on a passenger car

![Truck](Fig.2) Condition of the AILS mounted on a heavy truck

- Driving position

The lane mark on the road surface of the driving course was recorded by a CCD camera mounted on the roof of the test vehicle and a DV recorder. For analysis, the road surface and lane mark were identified by segmenting the video images, and the lateral distance between the central position of the lane mark and the outer surface of the vehicle was sampled at intervals of 10 Hz. The maximum lateral displacement until the end of operation was used as the index for evaluation.

- Subjective anxiety feeling

Subjects evaluated their anxiety due to the operation of the AILS while driving, using a seven-point scale (1 for “very relaxed” to 7 for “very anxious”). A score of 4 was presented to subjects as the upper limit of the allowable level while driving, and scores below 4 were used to indicate little or no anxiety about AILS operation while driving.

(4) Subjects

Eight males (age 23 to 48, with an average age of 40) who have driving license of heavy truck participated as subjects.

(5) Operation of the AILS

When the “beep” sound signaled the beginning of AILS operation while the subject was driving, the subject picked up the handset of the AILS, blew into the device for several seconds, and finally inhaled (Fig.3).

(6) Timing of signaling AILS operation

The experimenter who rode with the subject presented the “beep” sound to signal the operation of the AILS, so that the measurement points were aligned among subjects. Five conditions to start AILS operation were as follows.

- Straight section: Ordinary driving at a speed of 40 km/h.
- Avoiding a parked vehicle section: A distance of 80 m from the parked vehicle. Changing lanes and returning to one’s own lane while performing the operation.
- Curve section: Continuous driving on a curve until the end of the operation.
- Right turn at an intersection: Starting from the stop line. Operation during the right turn.
- Left turn at an intersection: Starting from the stop line. Operation during the left turn.

![Passenger car](Fig.3) Situation of operating the AILS while driving

(7) Test course

A simulated street (3.5 m wide, one lane in each direction) was used as the test course. To measure the stress of operating the AILS under various driving conditions, measurement points were set in the straight section, avoiding a parked vehicle, curve, and right and left turns at an intersection. At the point to avoid a parked vehicle, a passenger car was parked on the shoulder of the road.

(8) Procedures

After becoming skillful in AILS operation while parking (through more than 10 practices) and performing practice runs to learn the conditions of the test course by driving the test vehicle, measurement began. The upper limit of driving speed was set to 40 km/h for both straight and curved sections.

While the subject was driving, the experimenter used a “beep” sound in the preset measurement section to signal for the subject to...
begin AILS operation. Measurement was repeated three times, and the average was adopted as the typical value.

2.3 Results and discussion
(1) Subjective anxiety feeling

Although the average rating of subjective anxiety feeling was lower than the upper limit of the allowable level while driving in a straight section, avoiding a parked vehicle section, and driving on a curve. However if the scale 4 is the upper limit of the allowable level, some subjects felt anxiety above the upper limit while avoiding a parked vehicle and driving on a curve (Fig.4).

When turning right and left at an intersection while operating the AILS, the anxiety level was above the upper limit of the allowable level, indicating much anxiety.

The anxiety of the truck drivers while driving on a straight section and avoiding a parked vehicle was significantly higher than that of the passenger car drivers (p=0.05). It was considered that one of the causes of this result was that the mounting position of the handset in the truck was slightly farther from the driver’s seat than that in the passenger car. Therefore, we determined that the AILS should be mounted within the driver’s hand reach if the driver must operate the AILS while driving.

(2) AILS operation time
  • Reaction time

  Reaction time was defined as the amount of time from the “beep” signal to begin AILS operation until the driver’s hand left the steering wheel to operate the AILS (Fig.5). The reaction time was 0.6 sec in the straight section, avoiding a parked vehicle, and curved sections because few steering operations were required. The average and standard deviation of reaction time were large in the truck, which had a manual transmission, when turning right and left at an intersection because of the steering operation in addition to the necessity of looking to the right and left. Thus, the reaction time to start AILS operation might be longer in a truck than in a car.

  • Outward movement time

  The outward movement time was defined as the length of time from when the subject’s hand left the steering wheel until the subject picked up the AILS (Fig.6). After starting the operation, the average outward movement time was 0.7 sec, regardless of the driving point or the type of vehicle.

  • AILS operation time

  The AILS operation time was defined as the length of time between the subject’s picking up the AILS and blowing into the device to the subject’s returning the AILS to the mounted position (Fig.7). The AILS operation time ranged from 8 to 10 sec, with the maximum length recorded when avoiding a parked vehicle.

  • Returning movement time

  The returning movement time was defined as the length of time from the subject’s returning the AILS to the mounted position to the subject’s hand returned again to the steering wheel. The average returning movement time was 0.7 sec, the same as the outward movement time (Fig.8).

![Fig.4 Anxiety feeling while operating the AILS](image)

![Fig.5 Reaction time](image)

![Fig.6 Outward movement time](image)
passenger car (Fig.10). It was assumed that the glance time was slightly longer for the truck because the distance to the AILS mounting position was longer than that in the passenger car.

- Number of glances at the AILS until completion of operation
  Drivers glanced at the AILS two or three times until completion of operation (Fig.11).
- Total glance time at the AILS until completing operation
  The total glance time at the AILS until the operation was complete was 1.4 to 1.8 sec for the passenger car and 1.3 to 2.2 sec for the truck (Fig.12); thus, the side glance time for the operation was short. The guidelines of the Japan Automobile Manufactures Association indicate that the upper limit of the allowable total glance time to the navigator is 8 sec. However, because the level of anxiety was high when avoiding a parked vehicle, driving on a curve, and turning right and left at an intersection, it was conjectured that the stress of driving while picking up the handset and blowing into the device was large.

(3) Glancing behavior
- Single glance time
  The average single glance time related to the operation of the AILS was 0.6 to 0.9 sec; it was longer for the truck than for the
An alcohol tester was used to measure the volume of alcohol in the body through inspection of the BrAC. However, because confectionery and beverages other than liquor may contain alcohol, it is also probable that alcohol is detected after taking those beverages and confectionery. In the case of AILS mounted in vehicles, the acceptability for users will be lower because alcohol will be detected even though the driver is not intoxicated; thus, the engine will not start. Therefore, we investigated the effect of non-liquor beverages or food consumption on the BrAC.

3.1 Measurement using an electrochemical alcohol tester

(1) Test method

A device that used an electrochemical sensor equivalent to the AILS was used. Measurement was conducted before the subject consumed the food, immediately after consumption, and at 5-min intervals after consumption until the BrAC reached "0."

The subjects were six males (age 20 to 46, with the average age of 35).

Each subject consumed a piece of cake, jelly, and chocolate of which the ingredients label included alcohol. The subject was instructed not to drink water until the end of the test.

(2) BrAC after consumption of confectionery

With confectionery that partially attached to the mouth, the BrAC was high immediately after consumption, and alcohol was detected even 5 min after consumption. With confectionery that barely attached to the mouth (e.g., jelly), however, the BrAC was low even immediately after consumption, and no alcohol was detected after 5 min. Although the BrAC immediately after consumption of chocolate was very high, no alcohol was detected 10 min after consumption (Fig.14).

3.2 BrAC with consumption of non-liquor beverages measured by different alcohol sensors

Semiconductor sensors, which are relatively inexpensive, are
often used in offices. For the AILS, however, electrochemical alcohol sensors are used. These devices are expensive but provide high accuracy without interference from substances other than alcohol. Therefore, the BrAC after consumption of non-liquor beverages was measured using different sensors, and the difference in measurements was examined.

1. Test method

An electrochemical alcohol tester and a semiconductor alcohol detector were used to measure the BrAC immediately after consumption and at intervals of 5 min until the level returned to that before consumption of the beverage.

Subjects were the six males described in the previous section.

Each subject consumed two bottles of soft drink and a bottle of a nutrition supplement drink. The concentration of alcohol indicated by gas chromatography was 0.67 mg/L for soft drink A, 2.90 mg/L for soft drink B, and 0.06 mg/L for the nutrition supplement drink.

2. Measurement using an electrochemical alcohol tester

Alcohol was detected immediately after consumption because the beverage attached to the mouth. In the case of some soft drinks, the BrAC immediately after consumption may be at a level that would meet the criteria for drunk driving (0.15 mg/L). However, with the consumption of any kind of non-liquor beverage, no alcohol was detected 5 min after consumption (Fig.15).

3. Measurement using a semiconductor alcohol tester

In the measurement before consumption of a beverage, the indication of the ingredient in the breath was “around 0.01 mg/L.” In any kind of beverage containing alcohol, alcohol was detected after consumption. In the case of soft drink B, the BrAC immediately after consumption met the criteria for drunk driving, but it decreased to 0.01 mg/L after 5 min, and no alcohol was detected after 10 min. For the other non-liquor beverages, the BrAC immediately after consumption was 0.1 mg/L or lower, and no alcohol was detected after 5 min (Fig.16).

4. Conclusions

1. We examined the burden of AILS operation on the driver while driving on a test course.
   • Although the stress of operating the AILS was lower than the upper limit of the allowable level while driving in a straight section, anxiety in connection with operating the AILS was high when avoiding a parked vehicle, driving on a curve, and turning right and left at an intersection.
   • To reduce the operating stress, the AILS should be mounted in a position that facilitates operation by the driver within the hand reach of the driver.
   • Although the test result indicated that the driver’s anxiety level while driving in a straight line was below the upper limit, driving tests on public roads will be necessary to confirm this result.

2. The response of the BrAC after consumption of non-liquor beverages and foods was measured using electrochemical and semiconductor alcohol testers.
   • With confectionery that partially attached to the mouth after consumption, the BrAC was high immediately after consumption, a small amount of alcohol was detected 5 min after consumption, and no alcohol was detected after 10 min.
   • Both the electrochemical and semiconductor alcohol testers indicated a BrAC that met the criteria for drunk driving (0.15 mg/L) immediately after consumption of a non-liquor beverage or food. However, no alcohol was detected 5 min after consumption. Therefore, it was concluded that the driver should refrain from consuming any beverages or foods 5 min prior to using the AILS.
   • Semiconductor alcohol testers such as those mounted in offices may detect a BrAC above the criteria for drunk driving immediately after consumption of a non-liquor beverage or food. Therefore, it is necessary to refrain from consuming beverages and food for 10 min prior to the testing of the BrAC.
   • It is noteworthy that even an AILS that uses an electrochemical sensor may detect alcohol immediately after consumption of a
beverage or food.

References

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