AUTOMOBILES AND SAFETY

1 Introduction

The number of fatalities within 24 hours of a traffic accident in 2021 was 2,636, reaching the lowest total since the statistics were first maintained in 1948 for a fifth consecutive year.

Nevertheless, Japan has a higher percentage of pedestrian and cyclist fatalities among vulnerable road users than other countries, and frequent accidents due to mistakes by elderly drivers, as well as tragic accidents resulting from malicious or dangerous driving such as still far too common occurrences of drunk driving, among others, continue to present a bleak outlook on achieving the government target of reducing fatalities to 2,000 or less by 2025. Dealing with such accidents will require intensified cooperation between the public and private sectors and to adopt concrete integrated three-part measures that incorporate pedestrians, drivers, and the society.

2 Traffic Accident Trends and Measures

2. 1. Traffic Accident Trends

Annually, the number of traffic accident fatalities (within 24 hours of the accident) peaked at 16,765 in 1970, before falling to 8,466 in 1979 due to a range of measures to enhance safety. Traffic accident fatalities then began to trend back upward, peaking again at 11,452 in 1992. Since the year 2000, the number of fatalities fell in an increasingly gradual trend, reaching 4,113 in 2014. In 2015, fatalities rose to 4,117, a first increase in 15 years. However, in 2021, that number decreased by 7.2% from the previous year to 2,636, the lowest number since statistics were first maintained in 1948. The number of traffic accidents and injuries (including fatalities) has fallen since reaching a peak in 2004. In 2021, the number of injuries was 362,131, 2% less than in the previous year, and the number of traffic accidents was 305,196, a 1.3% decrease compared to the previous year. These numbers are at the same level as those between 1960 and 1965 (Fig. 1).

The following sections outline the salient characteristics of fatal accidents in 2021.

(1) Number of Fatalities per Road User Status

The total of 2,636 fatalities in 2021 breaks down to 941 pedestrian fatalities (down 6.1% from the previous year, 35.7% of the total), 860 fatalities while driving (down 2.5% from the previous year, 32.6% of the total), and 361 while riding a bicycle (down 13.8% from the previous year, 13.7% of the total). Although the number of fatalities has decreased by about 45% over the past 10 years, their proportions have remained almost unchanged, indicating that vulnerable road user fatalities are still high at about 50% (Fig. 2). Pedestrian and cyclist fatalities have continued to decline, and it is thought that this is due to the effectiveness of the three-part safety measures for improving safety, such as the increased adoption of pedestrian-aware collision mitigation braking systems, the application of collision damage mitigation braking systems to bicycles, continuous improvements to road infrastructure, and efforts to improve driving etiquette. At the same time, it is desirable to further improve the performance of active safety technology and spread new technology to further reduce the number of vulnerable road user fatalities.

(2) Increase in the Number of Elderly Fatalities

Breaking down traffic accident fatalities by age (Fig. 3) shows that there were 1,520 fatalities of people aged 65 or older, more than half of the total since 2012. In 2021, the proportion was 58% of the total, which was the highest ever. Pedestrians accounted for around half of these elderly fatalities (48%), which is over three times higher than the proportion for people under 65 (14%). In addition, the proportion of elderly people in the cyclist and pedestrian categories of fatalities was extremely high at 64%. This reflects the fact that elderly vulnerable road users account for a high percentage of the total number of victims.

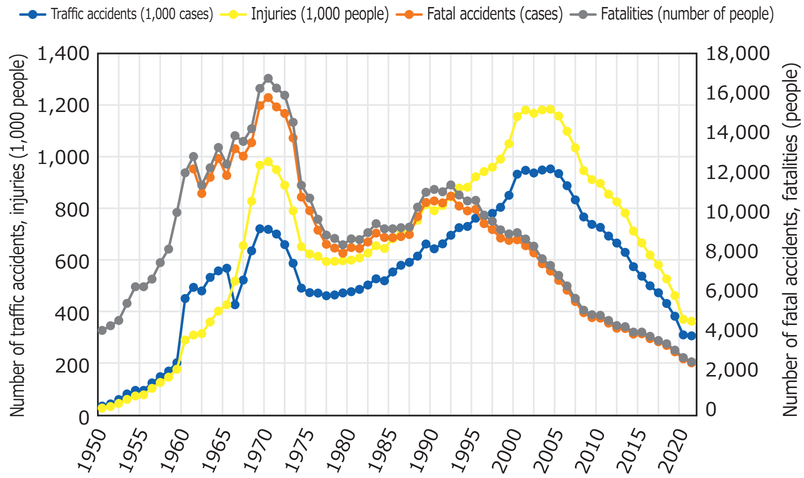

Fig. 1 Number of Traffic Accidents, Injuries, Fatal Accidents, and Fatalities

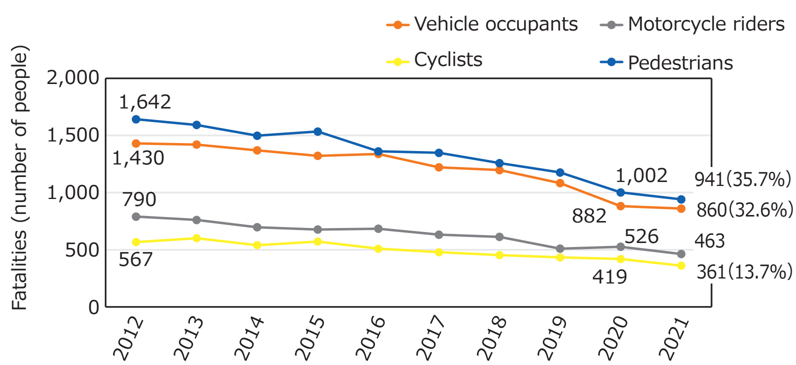

Fig. 2 Fatalities per Road User Status

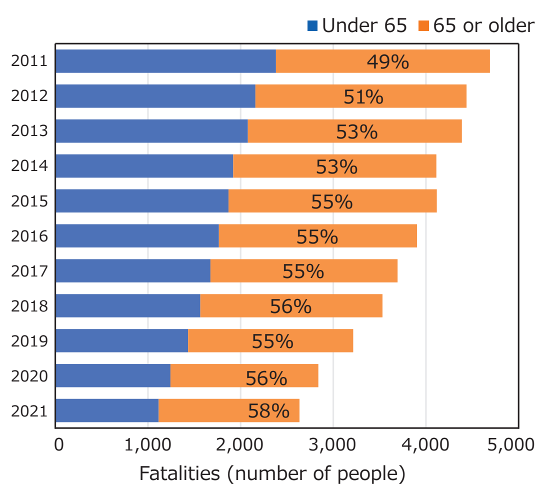

Fig. 3 Breakdown of Traffic Accident Fatalities by Age Group

Also, among fatalities while driving a vehicle, the number of deaths among elderly people aged 65 and over was 433, exceeding the 417 deaths for people aged 65 and under, and continuing to account for more than half of all vehicle occupant deaths since 2018 (Fig. 4). This difference is explained by the increase in accidents involving the elderly that follows from the higher number of elderly drivers, as well as by the greater risk of serious injury due to lower impact tolerance, which is a physical characteristic of elderly people.

In the future, the number of elderly driver's license holders aged 65 and over is expected to increase further, protecting the elderly is anticipated to become important to reduce not only vulnerable road user, vehicle occupant fatalities.

Accordingly, in addition to government-led measures to enhance traffic safety courses for elderly drivers and provide better support those who give up their license, initiatives that apply to vehicles are also becoming more and more important. These include active safety initiatives to compensate for the drop in cognitive, decision-making, and movement abilities that characterize elderly drivers, as well as passive safety initiatives adapted to the lower impact tolerance of elderly people if an accident does occur.

2. 2. Traffic Accident Measures

In March 2021, the Japanese government introduced

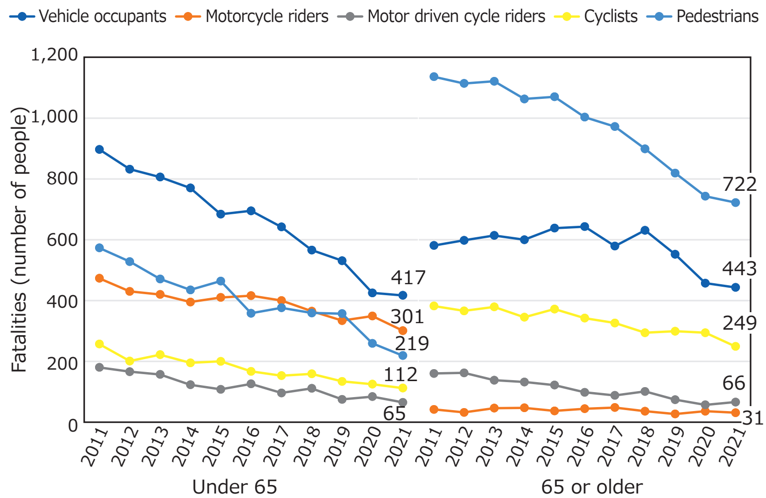

Fig. 4 Traffic Accident Fatalities per Road User Status

the Eleventh Fundamental Traffic Safety Program, which included targets to realize the world's safest road traffic environment, reduce the number of traffic accident fatalities within 24 hours of the accident to 2,000, and reduce the number of traffic accident fatalities and injuries to 22,000 by 2025. Following up on that program, the MLIT announced the Vehicle Safety Measures for Building a Society Free from Road Traffic Accidents in June 2021. These measures take a long-term perspective on vehicle safety and set the ambitious goal of aiming to eliminate all fatal accidents caused by newly launched vehicles that can be addressed using automobile technology by around 2035. The four pillars of those measures are described below.

(1) Ensuring Pedestrian, Cyclist and other Road User Safety

Many pedestrian fatal accidents occur at night or while driving straight ahead. This means vehicles should recognize or detect pedestrians early, even at night, and avoid a collision. On top of that, the key to next-level safety measures, will be to find ways to reduce collision speed to reduce fatalities or the degree of serious injury, even when a collision is unavoidable.

For bicycle accidents, vehicle-based measures are important to reduce rear-end collisions, which have an overwhelmingly high fatality rate, and head-on collisions, which account for the highest number of accidents.

(2) Ensuring Vehicle Occupant Safety

In an aging society with a declining birthrate, it is important to ensure the safety of children and the elderly. Along with the popularization of devices such as junior seats, it is necessary to promote the proper use of devices to improve actual occupant protection performance and spread the idea of traffic safety. In addition, the older the injured vehicle occupants is, the higher the percentage of fatalities due to chest injuries during collisions. This makes it appropriate to apply safety standards with stronger requirements for chest injury values (chest deflection) in frontal collisions, and to improve occupant protection performance starting with new vehicles. Based on the above, reducing traffic accident casualties in the future will require considering the possibility of improving occupant protection from a new perspective, in addition to improving conventional crash safety technology.

(3) Preventing Serious Accidents to Emphasized in Light of Social Circumstances

It is important to prevent accidents caused by driving operation errors made by elderly drivers, by health problems, by dangerous driving, and by heavy-duty vehicles, which are often serious accidents that cause extensive damage and have a strong social impact. A relatively large proportion of fatal accidents caused by elderly drivers are the result of driving operation errors such as improper steering and pedal misapplication. As the population continues to age, further measures to prevent the current 200 to 300 traffic accidents per year caused by health problems (e.g., epilepsy, heart attacks, or cerebrovascular disorders). In addition, there is no end in sight to extremely risky behavior such as using a smartphone or other careless actions that constitute dangerous driving and result in accidents caused by inattention. The heavy-duty vehicles that support logistics, public transportation, and other aspects of the transportation infrastructure are indispensable to modern society. However, their tremendous kinetic energy results in a relatively high fatality rate in collisions, and accidents involving such vehicles have an enormous impact on society.

(4) Promoting the Utilization and Appropriate Use of Automated Driving-Related Technologies

Although advances in the system-centered development and implementation of automated driving technology are expected, it will likely take some time for automated vehicles to become widespread. Driver-centered driving will remain predominant for the foreseeable future, and it will be essential to develop, put into practical use, and disseminate more advanced safe driving support technology operating under driver supervision to reduce traffic accidents in the short and medium term. At the same time, initiatives to research and develop system-centered automated driving technology and put them into practical use will be indispensable in the long-term to implement effective vehicle safety measures. It is essential for all drivers to correctly understand the purpose and limits of driving safety support devices, and use them appropriately, to proactively preventing traffic accidents following the spread of automated vehicles. This makes it necessary to examine various issues and take measures from the viewpoint of improving social acceptance of automated vehicles, as well as promoting the development and ensuring the safety of the automated vehicles themselves.

2. 3. Vehicle Safety Assessment Trends

(1) Trends in Japan

In active safety performance evaluations, bicycle collision damage mitigation brake performance evaluation was scheduled to begin in 2022. In addition, with respect to vehicles and pedestrians, there are plans to revise the testing and evaluation methods associated with mandatory equipment, as well as the testing and evaluation methods for pedal misapplication acceleration suppression devices. In terms of collision safety performance evaluation, a new frontal collision occupant protection performance evaluation using a mobile progressive deformable barrier (MPDB) and THOR dummies is being considered, and is scheduled to start in 2024. The conventional full-wrap front and offset front tests are scheduled to be reviewed at the same time. Furthermore, a new pedestrian leg

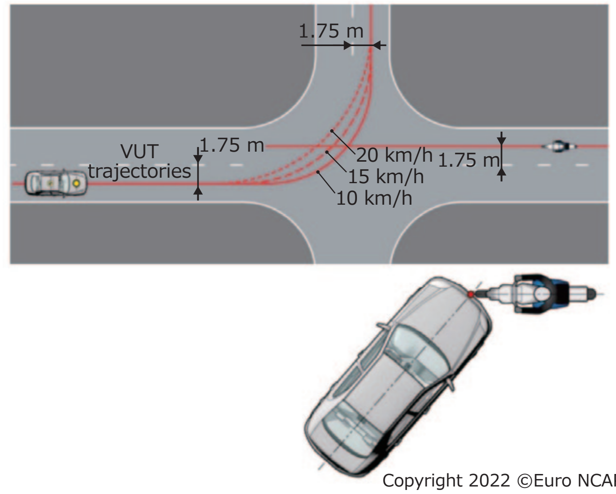

Fig. 5 AEB Performance evaluation for Euro NCAP Motorcycles

Fig. 6 Honda Legend (Level 3 Automated Driving)

protection performance evaluation test using the next-generation advanced pedestrian legform impactor (aPLI) is being considered, and the evaluation is scheduled to start in 2024. Since 2021, the JNCAP evaluation results are published as needed, with results for ten models were announced that year, and seven models received a five star rating.

(2) Global Trends

In the United States, major revisions of US-NCAP were stagnant under the previous administration. However, the Biden administration issued a call for public comments the proposed changes, and the revision process is being initiated. In addition, the IIHS is expanding the list of preventive safety performance evaluation items, and is actively adding preventive safety performance evaluation to the requirements for awards such as TSP/TSP+. Starting in 2023, Euro NCAP plans to start evaluating AEB (Fig. 5) for motorcycles, LSS, and AEB for oncoming vehicles. The Chinese C-NCAP and C-IASI were scheduled to start AEB evaluations for motorcycles in 2022, and also plans to introduce many other latest safety performance evaluations, such as collision safety and headlamp performance evaluations. Such cases of the newest safety performance evaluations being initiated by the Chinese NCAP are becoming more common. The trend of expanding active safety performance evaluations is also spreading worldwide, with indications that these latest evaluation items will be introduced in the Latin and ASEAN region NCAP in a few years, setting the stage for the global spread of active safety systems.

3 Research and Technology Related to Active Safety

Over the past 30 years, Japan has been worked through six phases of developing, commercializing, and promoting advanced safety vehicle (ASV) technology through industry-academia-government cooperation. The basic theme of the five-year Seventh ASV Promotion Plan initiated in 2021 is the further promotion of ASV for the advancement of automated driving, and specific technical requirements will be examined to stipulate guidelines on the development and commercialization of the advanced safety technologies necessary for the advancement of automated driving.

With respect to the commercialization of automated driving technology, Honda became the first Japanese manufacturer to off level 3 automated driving functionality with the release of the new Legend in March 2021 (Fig. 6). This level 3 automated driving system performs automated driving in traffic jams on the main lanes of expressways, requires a vehicle speed of less than 30 kilometers per hour as one of its activation conditions.

After conducting approximately 10 million simulations and field operational tests covering a total of approximately 1.3 million kilometers on Japanese highways, Honda announced that analyzing those simulations and tests showed that the congestion driving function could be expected to reduce accidents resulting in injury or death during highway congestion by half compared to manual driver operation.

Toyota introduced the EV e-Palette automated vehicle equipped with level 4 automated driving technology to serve as an autonomous shuttle for the athletes' village at the Tokyo Olympic and Paralympic Games (Fig. 7). The e-Palette operates automatically based on a plan made in advance, and can be stopped or restarted remotely in an emergency making it an automated vehicle with two levels of safety control.

Similarly, the German Mercedes-Benz announced in December 2021 that its Drive Pilot automated driving

Fig. 7 Toyota e-Palette

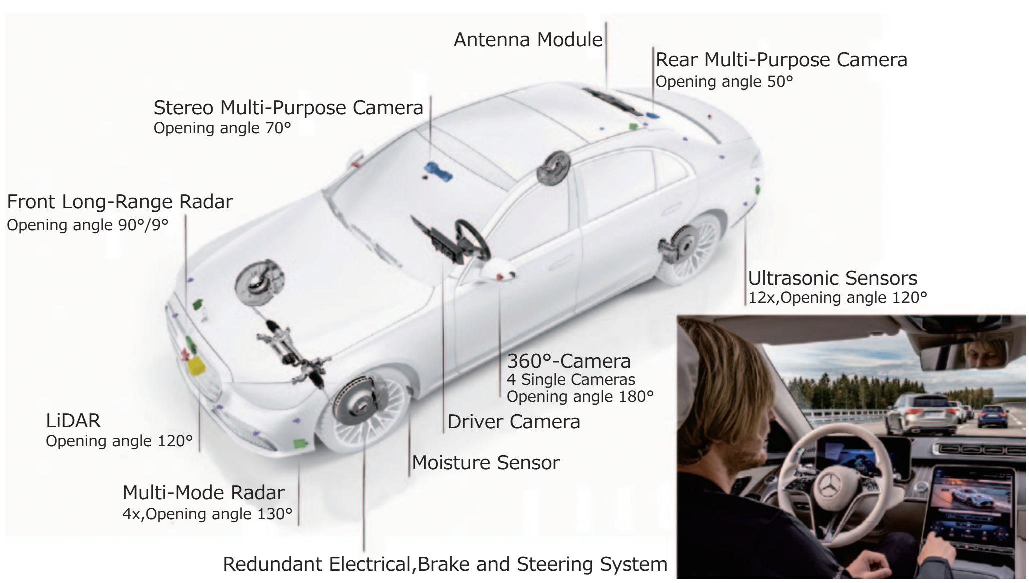

Fig. 8 Mercedes-Benz Drive Pilot in S-Class

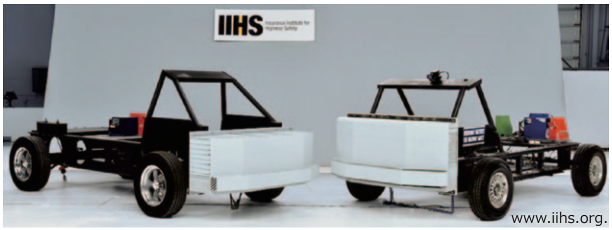

Fig. 9 New IIHS side impact test moving barrier (left) and old moving barrier (right)

Fig. 10 Mercedes-Benz SRS Rear Airbag

technology has acquired level 3 certification (Fig. 8). This technology conforms to UN-R157, and the system was certified by the German Federal Land Transport Office, the first such international certification conforming to UN-R157.

As already noted, major nations around the world have been amending their legislation to accommodate level 3 automated driving technology, and major manufacturers have started introducing vehicles featuring level 3 or higher technology into the market. Commercialization is expected to continue to advance gradually as legislation is established and market acceptance grows.

4 Research and Technology Related to Post-Accident Safety

The spread of active safety technologies could drastically reduce the occurrence of traffic accidents. Therefore, studies on regulations and assessments concerning active safety are gaining attention. However, current active safety technologies do not apply to all accidents, and it is difficult to completely eliminate all traffic accidents using these functions. Consequently, passive safety performance remains important. Authorities and research institutions in various countries are continuously analyzing accidents to ascertain their actual conditions, performing root cause analyses on injuries, studying technological countermeasures, and assessing new test methods or measurement devices.

4.1. New Test Methods and Measurement Devices

The adoption of test methods stricter than those in current tests is being researched and discussed based on actual accident conditions in various countries. For frontal collisions, MPDB and an advanced THOR dummy for frontal collision tests were adopted in Europe to evaluate a more realistic vehicle-to-vehicle accident. The introduction of these test methods is being considered in Japan and China, and is spreading worldwide. In the United States, the adoption of regulations on THOR is practically finalized. The inclusion of the THOR new frontal collision test method that employs moving barriers in the currently deliberated new US-NCAP is also under consideration.

For side impacts, Europe, Japan and China introduced the AE-MDB barrier and advanced WorldSID dummy for side impact tests. Tests using these new barriers and dummies apply different values for barrier mass, collision point, and collision velocity according to the situation the various countries. The adoption of WorldSID in North American US-NCAP side impact tests is also under consideration. In fiscal 2021, a new IIHS side impact test (Fig. 9) and a new moving barrier that simulates SUV collisions were introduced, and the test conditions were updated to a collision speed of 60 km/h and a barrier mass of 1,900 kg.

In addition, the development and introduction of advanced dummies that simulate various vehicle occupants continues to be studied. There is a strong focus on the THOR dummy and the WorldSID small female dummies, as well as on dummies that simulate the physical characteristics of elderly people, which will become crucial in the future. Test methods using a subsystem impactor that simulates a specific part of a pedestrian are commonly used in pedestrian protection performance evaluation tests. The advanced pedestrian protection leg impactor aPLI developed by ISO under Japanese leadership is scheduled for adoption in C-NCAP in China from 2021, and Japan, Europe, and the United States are also planning to introduce it. As shown above, efforts to set stricter impact conditions than those of current impact performance assessment tests, as well as introduce advanced dummies with superior bio-fidelity, are intensifying.

4.2. Protection Systems

Various seatbelt and airbag occupant protection systems adapted to various types of collisions are under de-

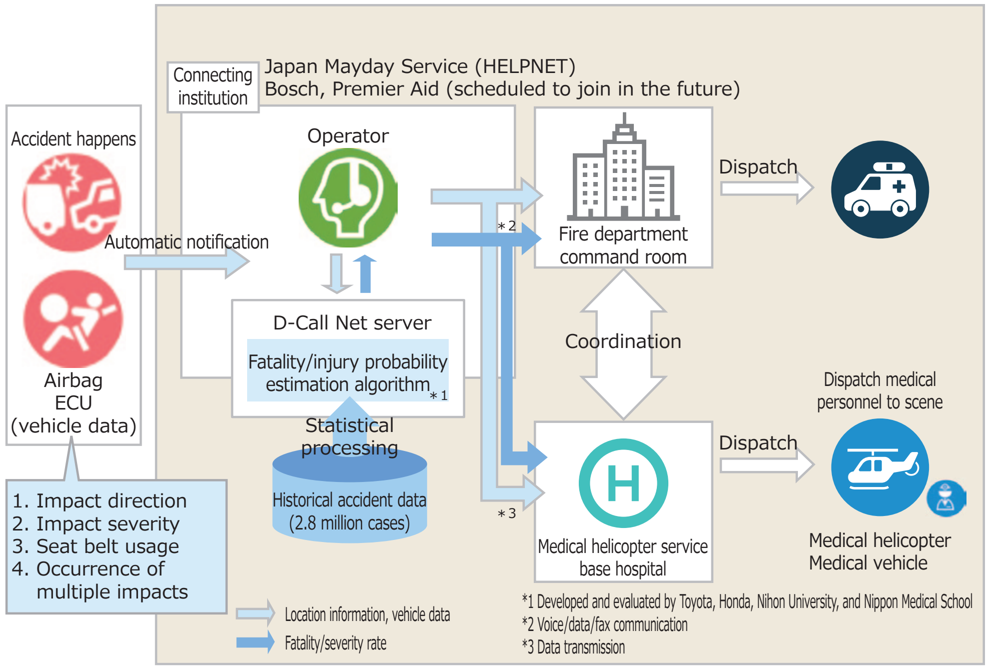

Fig. 11 Automatic Emergency Notification System (D-Call Net)

velopment of consideration. These include improvements to pretensioners that increase occupant restraint force and force limiters that control restraint loads, as well as airbags for far-side collisions, airbags that prevent occupants from being ejected from the vehicle, and airbags that protect rear-seat occupants in frontal collisions (Fig. 10). Occupant detection functions are also becoming more sophisticated, and devices such as driver monitors that detect the state of the driver, occupant detection using vehicle interior sensors and cameras, and child abandonment detection devices have been studied and adopted, and assessments are scheduled to start. In addition, the adoption of an interlock device that responds to seatbelt wearing or alcohol intoxication is also being considered. Airbags covering collisions between the head and a wide range of hard parts such as the A-pillar and windshield have been commercialized as protection systems for collisions between automobiles and the vulnerable road users exemplified by pedestrians and cyclists. Devices that coordinate with advanced active safety sensor systems to wind the seat belt, correct the seat position and adjust vehicle height, and devices that reduce the possibility of secondary injuries by having the airbag sensor activation signal trigger automatic braking, are already being commercialized as a future system. In addition, studies on passenger protection devices that can accommodate various passenger postures, including relaxed postures during future automated driving, have also begun.

4. 3. Automatic Accident Notification Systems

The survival rate of a person seriously injured in an accident is greatly affected by how long it takes for that person to receive emergency medical care. To shorten that delay, emergency notification systems that communicate the location of an accident and other information automatically immediately after a collision (ACN, e-Call) are in operation in Japan, the United States, Europe, and China. International standards were issued in 2018, and the relevant legislation and mandatory installation requirements are being implemented. Another system known as AACN, which transmits vehicle information (e.g., collision direction, severity of collision, deceleration, occupant seatbelt wearing) at the time of an accident and estimates the degree of injury based on that information, has begun operation in Europe, Japan and the United States. In Japan, AACN forms the basis of an automatic emergency notification system (D-Call Net) that makes early dispatch decisions for medical helicopters, which started trial operation in 2015 (Fig. 11). The JNCAP started announcing models equipped with ACN/AACN and introducing future-oriented trial performance assessment tests in 2017. Studies to make those systems also apply to pedestrian accidents are also underway to further expand their effectiveness.

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