**Title:** State Laws for Autonomous Vehicle Safety, Equity, and Insurance.

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**Keywords:**

Autonomous vehicles, Law/Legislation, Safety, Equity, Insurance

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**Précis:** This article reviews existing state laws related to autonomous vehicle (AV) safety, equity, and automobile insurance. Thirty states were identified with relevant legislation. Of these, most states had one or two relevant laws in place. Many of these laws were related to safety and insurance requirements. Data are needed to evaluate the effectiveness of these laws in order to guide further policy development.

**Introduction**

Autonomous vehicles (AVs) are a new type of motor vehicle that use internal sensing and computing equipment (instead of a human driver) to operate all functions as the vehicle moves on public roadways. AVs can take the form of passenger cars, trucks, buses, or other modes of ground transportation.1 A range of terms have been used for AVs, including “driverless vehicles,” “self-driving cars,” and “automated vehicles,” among others. While there is currently no universally accepted approach to naming AVs,2 the United States has adopted a classification system created by the Society of Automotive Engineers (SAE) which defines different levels of vehicle automation.3 The scale ranges from 0 (no automation) to 5 (full automation). Vehicles operating at Level 1, 2, or 3 may include limited forms of automation such as automatic emergency braking or adaptive cruise control. Vehicles operating at SAE Level 4 or 5 represent the highest levels of automation and can perform all the driving tasks without a human operator.

In 2020, motor vehicle crashes were responsible for an estimated 38,680 deaths and close to 3 million injuries in the United States.4 Crashes persist as a leading cause of death throughout the life span, with young people disproportionately affected.5 Human errors, caused by impairment, fatigue, and distraction, are present in over 90% of crashes.6 Therefore, the possibility that vehicles could drive without human involvement suggests that AVs have the potential to save thousands of lives. In spite of this, recent public opinion surveys indicate a growing majority of Americans are reluctant to use AVs.7 While current data, based on the relatively low numbers of AVs being tested, suggest that AVs have fewer and less severe crashes than human drivers,8 many millions and perhaps hundreds of billions of miles of driving experience will be needed to definitively demonstrate their reliability in terms of fatalities and injuries from crashes.9 Experience with conventional human-driven motor vehicles has shown that the public confidence benefits from effective safety regulation.10 Given the significance of safety in building trust in new technologies, an understanding of existing safety legislation for AVs could identify the current best practices as well as potential gaps in regulation.

Automobile insurance is another important consideration in the deployment of AVs, as it plays a complementary role to safety regulation in increasing consumer confidence in new technologies.11 In the U.S., automobile, insurance is governed by states, with each state establishing specific coverage requirements and some states regulating rates.12 While the impact of AVs on insurance is still unclear, some experts believe changes may be needed to the U.S. auto insurance system as vehicles incorporate higher levels of automation. These changes may depend on the ownership model for these vehicles (i.e., AVs owned and operated as a fleet compared to AVs that are owned and operated by individuals).13 Understanding current requirements for AV insurance and the amount of coverage currently required by states may help guide efforts to reform the insurance system to accommodate AVs.

In addition to addressing the safety and liability issues of AVs, policy can also be used to address disparities in transportation equity and access. Transportation is a social determinant of health because it facilitates access to education, employment, fresh food, health care, social services, and recreation.14 Transportation also forms an essential component of a functioning society because it impacts how individuals spend their time, where families decide to live, and places for communities to gather. The impact of transportation as a place-based source of health disparities among minorities and vulnerable groups has been extensively documented.15 Strategic deployment of AVs could extend and enhance mobility, especially among populations that have been under-served by the existing transportation system.16 For example, analysts estimate AVs could facilities new employment opportunities for approximately 2 million individuals with disabilities, and save $19 billion annually in health care expenditures from missed medical appointments.17

Over the last decade, AV legislation has been considered by the majority of US states,18 which has allowed over 1,400 driverless vehicles to be tested and deployed across the US.19 While this has enabled state-level testing and deployment of AVs, it has resulted in a patchwork of laws and regulations, which has constrained inter-state coordination. In 2019, the Uniform Law Commission proposed the Uniform Automated Operation of Vehicles Act.20 While this act included a framework that could reconcile the deployment of AVs within existing motor vehicle registration codes, it did not address the issue of equitable access to transportation, nor did it propose a harmonized approach to AV insurance. Federal policymakers have also attempted to pass legislation related to AV testing and deployment such as the AV Start Act. However, no federal legislation has yet been enacted at the time of this writing.21

Since the prevalence of AVs is still extremely low relative to other motor vehicles, little evaluation has been conducted on the range of AV laws that have been enacted. Further, most research on AV laws has focused on issues of liability and privacy, overlooking laws related to safety or equity.22 Developing a solid evidence base for AV laws is critical to motivate policy development and converge legislation around proven strategies and best practices. The purpose of this paper was to identify and analyze the range of state laws governing the safety and equity of AVs to facilitate the identification of evaluation opportunities.

**Methods**

We sought to identify US states with AV laws and abstract elements of those laws. The full text of state AV legislation and regulations were identified using standard legal research databases, including Westlaw and LexisNexis. A text search of these databases was conducted using the terms ‘autonomous vehicles,’ ‘self-driving,’ and ‘automated driving system’ — as well as variations of these terms — for all 50 states and the District of Columbia. In addition, state-specific general internet searches were conducted for gubernatorial executive orders related to AVs, as the Westlaw and LexisNexis databases do not routinely index executive orders. As a reliability check, we compared our findings with existing compilations of a subset of AV laws, regulations, and executive orders by the National Conference of State Legislatures23 and the Insurance Institute for Highway Safety.24 The searches were conducted between October 2019 and February 2021. Discrepancies were resolved by reference to the text of the laws and via discussion among the authors.

We limited the scope of this review to laws related to AV testing and deployment. Legislation, regulation, or executive orders related to the use of autonomous commercial semi-trucks or laws that were not directly applicable to AV use by the public (e.g., pilot testing projects for autonomous delivery vehicles) were also excluded. Each law was abstracted by at least two members of the study team. Once the abstraction was complete, a comprehensive table of the laws was developed. We then used the table to identify essential elements of such laws — lacking in many states — that relate to safety, equity, and insurance in the deployment of AVs. Detailed explanations were provided in cases where states with relevant laws differed from the other states in nuanced ways.

**Results**

As of February 2021, 30 states and the District of Columbia had relevant legislation, executive order(s), or regulation(s) related to AV testing or deployment (see Table 1). Links to the laws themselves have been posted to the website of the Johns Hopkins Center for Law and the Public’s Health: https://www.jhsph.edu/research/centers-and-institutes/center-for-law-and-the-publics-health/resources/autonomous-vehicles.html. Additional detail regarding the laws is provided in the footnotes to the table.

Relevant administrative regulations were identified in Arizona, California, Maine, Massachusetts, Nevada, and Pennsylvania. Executive orders related to AVs were identified in Arizona, Illinois, Maine, Massachusetts, Minnesota, Ohio, and Washington state.

Relevant variables for each law, executive order, or regulation were identified and abstracted, each of which fell into one of the following categories: 1) safety requirements; 2) equity and accessibility; 3) insurance and liability; 4) penalties for non-compliance; and 5) pre-emption of local laws.

Some state requirements vary according to the level of automation in the vehicle. For example, Nebraska does not require a human operator physically present in the AV if the vehicle’s automated driving system (ADS) can achieve a minimal risk condition while driving. In their widely used J3016 standards for AVs, SAE defines a minimal risk condition as “a stable, stopped condition to which a user or an ADS may bring a vehicle … to reduce the risk of a crash when a given trip cannot or should not be continued.”25

**1. Safety Requirements**

Five elements were abstracted related to AV safety, including requirements for: (1) a human operator of the AV with a driver’s license; (2) a human driver to be able to override the AV system; (3) data capture during disengagement of the autonomous functioning of the vehicle; (4) data capture during a crash; and (5) safety incident reporting. Columns corresponding to these five elements are shaded grey in Table 1.

No jurisdiction had legislation that addressed all five safety-related elements. In the District of Columbia, Massachusetts, Michigan, and Pennsylvania, AV legislation covered four elements (requirements for a human operator, human driver override, data capture during a crash, and safety incident reporting). Three states (CA, NV, and UT) covered three elements, but these differed among each state. Another twelve states (AL, AZ, CT, FL, GA, IA, ME, NE, NC, ND, OH, and TX) addressed two elements. Nine states (CO, HI, IL, LA, NH, NY, TN, VT, and WA) addressed only a single safety requirement; for seven of these nine states, this was the human operator with a driver’s license requirement. Three states (AR, MN, and OK) did not address any safety-related elements.

*Human operator with a driver’s license*: Six states require that AVs must have a human operator and that this individual must have a driver’s license and be physically present in the vehicle during its operation (CT, IL, MA, MI, NY, and PA). Two states require a human operator with a driver’s license but do not require the operator to be physically present in the vehicle in all cases (CA and OH). Two jurisdictions require a physical human operator but do not specify whether this operator must hold a valid driver’s license (DC and HI). Laws in ten states (AZ, GA, IA, NE, NV, NH, NC, ND, UT, and WA) do not require a human operator for certain classes of AVs (e.g., fully autonomous vehicles) but still require a human operator for AVs with more limited capabilities. Six states (AL, CO, FL, LA, ME, and TX) do not require a human operator for any AV, and five states (AR, MN, OK, TN, and VT) do not specify whether a human operator with a license is required to operate an AV.

*Human driver override:* In the event of an emergency or failure of the ADS, four jurisdictions (CA, DC, FL, and PA) require the AV to notify the human operator and either transfer control of the vehicle to the human operator or achieve a minimal risk condition. Six states have provisions that only require a human operator to take control of the AV after an ADS failure (AZ, CT, MA, MI, NV, and UT). Five states only require that the AV be able to achieve a minimal risk condition without the use of a human driver (AL, GA, NE, ND, and TN). The remaining sixteen states did not address this topic.

*Data capture during AV disengagement*: An AV disengagement occurs when a human operator takes manual control of the vehicle. These events occur due to technology failure or situations in which the human operator judged that the AV system could not operate safely. California was the only jurisdiction that required AVs to store and capture data when an AV disengagement occurs. This California law specifies that these data should be summarized and reported to the California DMV annually. Disengagement data is intended to provide safety agencies with a better understanding of the operational limits of AVs and the circumstances where human intervention was needed.

*Data capture during AV crash:* Seven jurisdictions (CA, DC, MA, MI, NE, PA, and TX) required incident data to be captured and reported in the event of an AV crash. California requires sensor data to be captured for a minimum of 30 seconds before and after a collision occurs. These data must also be downloadable and preserved for up to three years after the collision date. Texas requires AVs to record data, including vehicle speed, location, and use of the steering wheel and brakes. Generally, the availability of AV sensor data before and during crashes is intended to assist safety agencies in understanding factors contributing to a crash.

*Safety incident reporting:* In twelve jurisdictions (DC, IA, ME, MA, MI, NE, NV, NC, OH, PA, UT, and VT), AVs are held to stricter reporting requirements than human-operated vehicles are. Iowa imposes penalties for AV vehicle owners if their vehicle fails to remain on the scene of a crash and report the crash to authorities. The District of Columbia requires AV operators to report any crash within 12 hours, while Nevada requires AV operators to report crashes that result in personal injury or property damage greater than $750.

**2. Equity and Accessibility**

One element was abstracted related to equity and accessibility.

*Equitable Access or Disability Accommodations:* Eight jurisdictions had laws related to equitable access or disability accommodations (CO, DC, IL, ME, MN, NV, OK, and WA). The District of Columbia outlines non-enforceable ‘principles’ for equitable testing of AVs across the city’s four quadrants. Washington state mandates that a working group must explore the impacts of AVs on social services, and Minnesota specifies that an AV council must work with people who have trouble accessing transportation options. In Nevada, AV passengers must have the ability to indicate whether they require a wheelchair-accessible vehicle. If the AV company does not have a wheelchair-accessible vehicle available, they must direct the passenger to an alternative wheelchair-accessible transportation provider. Oklahoma law requires AV pilot programs to collaborate with the Departments of Veterans Affairs, Rehabilitation Services, and Mental Health, and the Association of Centers for Independent Living. Maine law requires the state AV advisory committee to include representation from the state Office of Aging and Disability Services.

**3. Insurance and Liability**

Two elements were abstracted related to insurance: an insurance requirement for AVs and the insurance amount required.

*Insurance Requirement:* Insurance was required for AVs that are tested or deployed in 27 jurisdictions (AL, AR, AZ, CA, CT, DC, FL, GA, IL, IA, LA, ME, MA, MI, NE, NV, NH, NY, NC, ND, OH, PA, TN, TX, UT, VT, and WA).

*Insurance Amount:* Fourteen jurisdictions set the amount of insurance coverage that the AV operator must provide (AL, CA, CT, DC, FL, LA, ME, MA, NV, NH, NY, TN, VT, and WA). These amounts ranged between one and eight and a half million dollars, with the most common requirement being five million dollars. Ohio was the only state to require insurance without specifying the amount of insurance coverage required. Eleven states (AR, AZ, GA, IL, IA, MI, NC, ND, PA, TX, and UT) set an insurance amount equivalent to the amount required for human-operated vehicles. Nebraska set a specific insurance amount for AVs tested without a human operator but required all other AVs to be covered by the same amount as human-operated vehicles.

**4. Penalties for Non-Compliance**

*Penalties for non-compliance:* Fourteen jurisdictions (AZ, CO, CT, DC, IL, IA, ME, MA, NV, NH, OH, PA, UT, and VT) included penalties for AV operators that failed to comply with the laws required for testing and deployment. These ranged from financial penalties to suspension or termination of permission to operate AVs within the state.

**5. Pre-emption**

*Pre-emption:* This refers to the ability of a higher level of government to supersede or prevent specific actions at lower levels.26 This element indicates whether state laws prohibit local AV laws or regulations from being enacted or enforced. Ten states explicitly pre-empted local AV laws (CO, FL, IL, IA, LA, NH, NC, ND, OK, and UT). In Illinois, local governments can only pass AV traffic control regulations. Oklahoma pre-empts any local government from passing AV restrictions or regulations and prohibits any existing local AV laws from being enforced; however, Oklahoma has not enacted any other meaningful AV legislation at the state level. This nearly ensures that AVs will not be regulated anywhere in Oklahoma until the state legislature takes further action.

**Discussion**

State laws related to the safety, equity, and insurance requirements of AVs have the potential to advance public health as well as increase public confidence in this new technology. This review found that there was wide variability in state laws on these issues, and that most states had only one or two such laws in place. While most states were silent on the equity issue, insurance requirements appeared in 27 jurisdictions. Ten states explicitly pre-empted local laws on AVs, and penalties for AV operators who do not comply with AV laws were present in 14 jurisdictions.

Innovations in transportation are often accompanied by the need for legislation and regulation to ensure an adequate level of safety. Historically, legislation has typically emerged following incidents involving a loss of life or highly publicized events.27 This reactive approach allows policies to be informed by examination of the actual circumstances surrounding the event and therefore based on objective empirical evidence. However, this evidence comes at the cost of severe injury and death, particularly if safety incidents are ignored or there is a protracted period between these events and relevant legislation. A more proactive approach to policy development could be based on a combination of prediction models, simulation, and engineering analysis and has the potential to prevent crashes before they occur, avoiding loss of life. The development of policy based on theoretical information rather than empirical evidence still comes with risk, such as loss of life that followed the introduction of passenger-side airbags in the 1990s and their tragic implications for child safety.28 Legal scholars have argued that proactive legislation presumes a problem that may not yet or ever exist, and balances the well-aligned interests of buyers and sellers against those of individual victims who have yet to be identified.29 A further concern is that well-intended proactive regulations could unnecessarily impede innovation and delay the introduction of technologies that have the potential for widespread safety and equity benefits.

Experience with Federal Motor Vehicle Safety Standards suggests that regulations are likely to serve a critical role in determining the public benefits resulting from AV deployment.30 The need for a balance between proactive and reactive approaches further suggests that a deliberate, thoughtful, and coordinated strategy to guide the initiatives of city, state, and federal regulators is far more likely to yield a favorable outcome than will an array of independent efforts. Identifying a focal point and process for a coordinated national approach is an essential step but is technically and politically challenging. Conducting and disseminating AV policy evaluations and research is a prerequisite that could facilitate progress and provide a foundation for a coordinated national regulatory approach. Such an approach to AV policy could recognize the value of empirical evidence and encourage the initiation of policy evaluations as soon as outcome data are available. As the scale of AV deployments is still modest, and fatality and injury data will be slow to accumulate, near-term evaluations may need to be based on other criteria such as near-crash events. Safety advocates have argued that such a proactive approach should include mandatory data capture requirements in the event of crashes or AV system disengagements.31 NHTSA has launched a voluntary program for data sharing,32 and recently required mandatory reporting of critical safety events.33

Another important focus of a coordinated national regulatory approach should be equitable access for vulnerable communities or populations. The deployment of AVs can be influenced by public policy and should be considered as a public health intervention. Because of their potential to deliver mobility with minimal cost, AVs may be able to improve access by underserved communities to social determinants of health such as health care, education, employment, and nutritious food. Policy development is lagging in this area and should be stimulated through public health leadership.34

Some legal scholars have argued that AVs are such a dramatic departure from existing vehicles that they require a distinct process for establishing safety standards.35 Others suggest AVs could be integrated into existing legal conventions and state legislation.36 A new process should be comprehensive, ensuring control of safety and equity by placing authority for vehicle safety, use of the roads, and equitable access at the levels of government that provide the greatest effectiveness and efficiency. The regulatory system for conventional vehicles has evolved over 100 years and is distributed across different levels and sectors of government. The system for AVs will be at least as complex. A coordinated national approach supported by a comprehensive body of evidence-based policy is most likely be effective.

By its very nature, any review of state laws is limited in time and scope. Laws and regulations are subject to change, meaning that the findings of this analysis and the summary of laws presented in the table will not remain accurate over time. Ongoing research is needed to maintain an updated landscape analysis of existing AV legislation, and further research is needed to determine which elements of these state laws would constitute model legislation for AV testing and deployment.37 Additional data are also needed to understand how these laws are implemented and enforced and how they impact AV testing and deployment. This effort to review state laws for AV safety, equity, and insurance is a step toward identifying opportunities for state AV legislation that promotes the public benefit and increases consumer confidence in this new technology.

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