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Potential injuries and costs averted by increased use of evidence-based behavioral road safety policies in North Carolina

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Abstract

Objective: The purpose of this study was to estimate the potential injuries and costs that could be averted by implementing evidence-based road safety policies and interventions not currently utilized in one U.S. state, North Carolina (NC). NC consistently has annual motor vehicle-related death rates above the national average.

Methods: We used the Centers for Disease Control and Prevention's Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MV PICCS) tool as a foundation for examining the potential injuries and costs that could be averted from underutilized evidence-based policies, assuming a $1.5 million implementation budget and that income generated from policy-related fines and fees would help offset costs. We further examined costs by payer source.

Results: Model results indicated that seven interventions should be prioritized for implementation in NC: increased alcohol ignition interlock use, increased seat belt fines, in-person license renewal for ages 70 and older, license plate impoundment, seat belt enforcement campaigns, saturation patrols, and speed cameras. Increasing the seat belt fine had the potential to avert the greatest number of fatal (n=70) and non-fatal (n=6,597) injuries annually, along with being the most cost-effective of the recommended interventions. Collectively, the seven recommended evidence-based policies/interventions have the potential to avert 302 fatal injuries, 16,607 non-fatal injuries, and $839 million annually in NC with the greatest costs averted for insurers.

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Conclusions: This study demonstrates the utility of the MV PICCS tool as a foundation for exploring state-specific impacts that could be realized through increased evidence-based road safety policy and intervention implementation. For NC, we found that increasing the seat belt fine would avert the most injuries, had the greatest financial benefits for the state, and the lowest implementation costs. Incorporating fines and fees into policy implementation can create important financial feedbacks that allow for implementation of additional evidence-based and cost-effective policies/interventions. Given the recent uptick in U.S. motor vehicle-related deaths, analyses informed by the MV PICCS tool can help researchers and policy makers initiate discussions about successful state-specific strategies for reducing the burden of crashes.

Keywords

Road Safety; Motor Vehicle Crashes; Behavioral Policy and Intervention; Economic Cost

INTRODUCTION

Motor vehicle crashes (MVCs) are a leading cause of fatal and non-fatal injury in the United States (US). MVCs are responsible for 30,000 to 40,000 fatalities and more than 2.5 million non-fatal injuries annually (CDC, 2005). Injuries sustained in MVCs result in numerous long-term negative physical and mental health outcomes, decreases in health-related quality of life (Alghnam et al, 2015), and enormous medical costs and productivity losses (Blincoe et al, 2015). In 2010, the estimated economic cost of MVCs in the US was $242 billion, with a lifetime economic cost to society of $1.4 million per fatality (Blincoe et al, 2015). While advancements in road safety policy and implementation of effective interventions have contributed to declines over the last several decades, progress has plateaued, and recent fatality rates in some road user groups, notably pedestrians, have begun to trend upwards. The scale and persistence of this public health problem have led thought leaders and communities to adopt more holistic approaches to road safety, including the Safe Systems approach.

Safe Systems principles include designing road systems that prevent injury by reducing human error through safe behaviors, reducing the impact of consequences for all road users when human error does occur, reducing the transfer of kinetic energy by design elements, and incorporating coordinated action from multiple stakeholders with a shared responsibility for safety (Organization for Economic Co-operation and Development, 2008). Therefore, promoting, supporting, and maximizing safer road user behaviors is one key element of this approach. Safe Systems has served as the basis for several recent and transformative road safety efforts, including Vision Zero, a systems-based approach that aims to eliminate fatal and severe non-fatal injuries from MVCs while improving mobility for all individuals (Naumann et al, 2019).

In developing a comprehensive plan for implementing a Safe Systems approach, several underutilized interventions are available to support safer road users. And, as vehicle miles traveled (VMT) consistently increase in a monotonic manner each year across the U.S., there is a pressing need to explore how such underutilized interventions might fit into a larger transformation of motor vehicle crash and injury prevention. The purpose of this study was

to quantify the potential reductions in injury incidence and cost that could be realized by integrating underutilized behavioral road safety interventions in one US state (North Carolina).

METHODS

To provide context for examining potential impacts of increased implementation of behavioral road safety policies and interventions ('interventions') in North Carolina (NC), we first examined recent US and NC road safety trends and the current behavioral road safety intervention landscape in NC. We then calculated NC-specific estimates of potential reduction in injury incidence and costs (stratified by payer source) that could result from large-scale implementation of these specific interventions. The US Centers for Disease Control and Prevention's (CDC) Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MV PICCS) tool (version 3.0) was used as the foundation for computing these state-specific estimates (Ringel et al, 2015). Additional references can be found in the Appendix.

Road safety trends and behavioral road safety intervention landscape

To calculate road traffic fatality rates, we used US and NC-specific annual counts of MVC fatalities between 1999 and 2017 from the CDC's Web-based Injury Statistics Query and Reporting System (WISQARS™) Fatal Injury Reports and annual VMT data from the US Department of Transportation Federal Highway Administration's Highway Statistics database. US and NC road traffic-related fatality rates were calculated as fatalities per billion VMT per year.

To understand the behavioral road safety intervention landscape in NC, we identified behavioral road safety interventions and policies currently implemented in NC using online databases provided by the National Highway Traffic Safety Administration, Insurance Institute for Highway Safety, Governors Highway Safety Association, and National Conference of State Legislatures. Details about each intervention, including the targeted population (e.g., age groups, road user type) and enactment date, were extracted from legislative documentation obtained from the NC General Assembly. We present initial implementation and notable updates to road safety interventions in a timeline.

CDC's Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MV PICCS) tool

The MV PICCS tool provides state-specific recommendations for prioritizing implementation of behavioral road safety interventions (Ringel et al, 2015). The interventions included in MV PICCS were those that met the following criteria: 1) aimed at changing motorist behavior; 2) empirical evidence of substantive injury reductions; 3) implemented in fewer than two-thirds of US states; 4) strong potential for implementation at the state level; and 5) identified as an effective intervention, supported by the highest quality research base across a range of road users (e.g. teen drivers, older drivers, bicyclists).

Based on these criteria, fourteen behavioral interventions were included in MV PICCS. The fourteen interventions address automated enforcement (red-light cameras and speed-

cameras); seat belt and helmet use (primary enforcement of seat belt laws, high-visibility seat belt enforcement campaigns, increased seat belt fines, bicycle helmet laws for children, universal motorcycle helmet laws); reducing impaired driving (alcohol ignition interlocks, sobriety checkpoints, saturation patrols, license plate impoundment, limits on diversion and plea agreements, vehicle impoundment); and in-person license renewal for drivers ages 70 and older.

For the purposes of this study, we sought to identify which interventions would result in the greatest number of injuries prevented and costs averted in NC. The model requires input of an initial intervention implementation spending budget. We estimated a $1.5 million initial spending budget, which we consider a realistic value as it represents approximately 10% of the total NC Governor's Highway Safety Program's approved program costs for FY2017 (NC Department of Transportation, 2017). In addition to this initial budget, we further customized the model to include revenue from fines and fees (e.g., from seat belt tickets) in overall cost and effectiveness calculations.

Only interventions not already fully implemented in NC were considered for inclusion in the model. For example, NC currently issues alcohol interlocks to driving while impaired/intoxicated (DWI) offenders only under very specific circumstances (only repeat and high-BAC first-time offenders). Clearly there is considerable potential to increase the intensity of this intervention (e.g. to all DWI offenders) and therefore it was included in the model.

Fatal and non-fatal injuries averted

Detailed methods on how the model calculates fatal and non-fatal injuries prevented, costs averted, and net implementation costs for each intervention are described elsewhere (Ringel et al, 2015; Ecola et al, 2018). Briefly, the empirical evidence base was used to identify estimates for fatal and non-fatal injury averted for each intervention, considering the methodology used, assumptions made, geographic location, and dates of data used in the estimation process of each study assessed. When estimates were not available in the literature for either injury type, published methods relying on proportional impacts were utilized to calculate fatalities averted for each non-fatal injury averted, or vice versa (Ringel et al, 2015). Lastly, state-specific fatality data (Fatality Analysis Reporting System) and national non-fatal injury data (General Estimates System) from NHTSA were used to estimate counts of fatal and non-fatal injury in each state (Ringel et al, 2015).

Net costs to implement and total costs averted by intervention implementation

The MV PICCS model estimates the net costs to implement each intervention as the estimated implementation cost reduced by the fines and fees generated from intervention implementation (when fines and fees are included in the model). Depending on the intervention, the model assumes these estimated implementation costs are for publicity, patrol time, court system, the department of motor vehicles, equipment, probation, education, vehicle impoundment, and program management costs. Fines and fees were defined as costs paid by individuals that resulted in revenue to state or local government.

Total costs averted by each intervention were calculated by monetizing the value of injuries and fatalities averted using cost estimates from Blincoe et al. (2015). Cost estimates were

adjusted for inflation, state-level variation, and injury severity (Ringel et al, 2015). Estimates included costs of medical care, emergency services, market productivity losses, household productivity losses, insurance administration, travel delays, and property damage, as well as workplace and legal costs. We then stratified total costs averted (computed by the MV PICCS model) by payer source, including state and local government, federal government, private insurers, self-pay, and other sources, using previously estimated national percentages (Blincoe et al, 2015).

This study was reviewed and approved by the Institutional Review Board at the primary author's home institution (University of North Carolina-Chapel Hill).

RESULTS

Road safety trends and behavioral road safety intervention landscape

Between 1999 and 2017, there were 29,514 and 775,333 motor vehicle (MV)-related fatalities in NC and in the US overall, respectively. Overall, rates of MV-related fatalities per billion VMT per year decreased in NC (from 18.29 to 12.81 fatalities per billion VMT) and in the US (from 15.84 to 12.60 fatalities per billion VMT) during this period (Figure 1). Rates reached their lowest level in 2011 for NC (12.18 fatalities per billion VMT) and in 2014 for the US (11.78 fatalities per billion VMT), followed by a general increasing trend through 2017 for NC and an upward trend starting in 2014 from the US perspective. On average, NC road traffic fatality rates were about 1.12 times higher than national rates across this period.

Figure 2 documents the timing of key behavioral road safety interventions enacted in NC between 1965 and 2018, including interventions considered in MV PICCS, as well as several other significant interventions implemented during this period. Notable interventions implemented across this 50-year time frame included legislation aimed at helmet use (for motorcyclists and bicyclists), restraint use, speed reductions/limits, distracted driving, and DWIs. Of note, the 1983 Safe Roads Act was a key piece of legislation that combined and updated all previous DWI-related legislation, and added stricter provisions for consequences (e.g. mandatory jail sentence of at least 7 days for second offenders) (National Highway Traffic Safety Administration, 1985). Since then, DWI-related legislation has been updated many times to change and add to the types of penalties, including alcohol ignition interlocks, license plate impoundment, vehicle impoundment, and limits on diversion and plea bargaining, as well as saturation patrols and sobriety checkpoints to monitor for potential offenders (Table 1). The earliest NC restraint legislation was enacted in 1981 as a child passenger safety law, followed by the first seat belt law in 1985, covering only drivers and front seat passengers. The latter was updated in 2006 to include all occupants, with primary enforcement in front seats. To further enhance restraint use, NC was the first state to implement the 'Click It or Ticket' campaign in 1993, which has since been adopted in states across the US. The most recent behavioral road safety interventions implemented in NC have targeted distracted driving with a texting and emailing ban (for all ages) enacted in 2009.

Potential injuries prevented and estimated costs averted

Using a hypothetical initial budget of $1.5 million and inclusion of fines and fees to offset costs and potentially increase overall budget, seven behavioral road safety interventions were prioritized and recommended for implementation in NC (Table 2). Increasing the seat belt fine led to the greatest number of fatal (n=70) and non-fatal (n=6,597) injuries prevented annually. This was also the most cost-effective intervention, with the lowest implementation cost ($0) and greatest economic benefit ($256,791,000), given that sweeping changes (such as increased enforcement intensity) would be unnecessary since a lower seat belt fine already exists in NC. Among the remaining interventions, speed cameras and saturation patrols had the greatest potential benefits ($158,982,000 and $140,863,000, respectively). Overall, adjusted analyses of the seven prioritized policies indicated an annual 302 potential fatalities and 16,067 potential injuries averted, as well as $838,844,000 in total costs averted.

When we estimated costs averted by payer source, hypothetical implementation of the seven interventions were estimated to result in a total of $25,165,320 in averted costs to state and local government annually (Table 3). Increased seat belt fines were estimated to result in the greatest costs averted to government (state, local, and federal) compared with other potential policies. The largest proportion of costs averted from hypothetical implementation of all policies were to private insurers, with an estimate of over $450 million in costs averted.

DISCUSSION

Motor vehicle crashes are a source of significant health, financial, and emotional burden to individuals, families, and communities (Blincoe et al, 2015). Although national rates of MV-related fatalities per billion VMT per year have decreased from 15.9 in 2000 to 12.1 in 2011, there has been minimal change since. In NC, rates have followed a similar pattern to national trends, and have consistently remained higher than the national average. The Safe Systems approach seeks to markedly change the way we approach road safety, by creating a safer transportation system through the holistic and coordinated action of multiple stakeholders to construct a system that encourages safe human behaviors, prevents injury in the event of human error, and limits the uncontrolled transfer of kinetic energy in a crash situation. Current legislative and programmatic interventions for road users have proven to be effective strategies in reducing road traffic fatal and non-fatal injuries. While they are an important piece of a larger systemic solution to improving road safety, it is clear that there is ample room for continued improvement.

The intervention landscape surrounding road safety is complex, with legislation enacted at multiple levels of government (local, state, and federal). At a state level, NC has often been at the forefront of behavioral road safety intervention implementation in terms of seat belt enforcement campaigns, graduated drivers licensing, and universal motorcycle helmet legislation. However, like most US jurisdictions, the state has yet to fully employ evidence-based solutions. For example, it has low utilization rates of alcohol ignition interlocks after DWI incidents (Casanova-Powell et al, 2015).

We hypothesized an alternative NC in which $1.5 million annually was invested in evidence-based interventions that are not currently implemented or underutilized. Using MV PICCS,

in this counterfactual NC, three new interventions and four updated interventions that are currently underutilized, could be deployed across the state (new: increased seat belt fines, speed cameras, and in-person license renewal for drivers ages 70 and older; underutilized: seat belt enforcement campaigns, alcohol ignition interlocks, saturation patrols, and license plate impoundment). As a system, these seven interventions would target significant risk factors for motor vehicle crash injuries including the three largest behavioral contributors: not using seat belts, impaired driving, and speed. Collectively, these seven interventions could avert 16,067 injuries and 302 fatalities, and could potentially result in more than $838 million in total averted costs in NC. This translates to averting 12.6% and 21.6% of all crash-related non-fatal and fatal injuries, respectively. The hypothetical total annual costs averted to state and local governments from implementation of these seven intervention strategies would be $25 million.

Generally, our findings suggest that discussions around road safety improvements in NC should include consideration of increased enforcement and monitoring of seat belt use, speeding, and impaired driving. However, the interventions included in MV PICCS are all behavioral in nature. While these interventions are evidence-based and effective at improving road user safety, they are only one part of a comprehensive road safety system. Ideally, such systems should consider not only human factors, but also transport and land use, economic and social contexts, road infrastructure, the natural environment, vehicles themselves, and safety management and crash medical response systems. For example, applying Safe Systems principles, the Swedish Road Administration relies heavily on engineering and design principles to limit speed and separate different types of road users, while also acknowledging that speed monitoring and other interventions have a role to play (Johansson, 2009). Further, advances in technology have seen more and more built-in vehicle safety features, such as seat belt use reminders, encouraging desired behaviors. Therefore, while working toward implementing effective interventions and technological advances to increase seat belt use, and reduce impaired driving and speeding, a broader conversation about how to also make advances in local infrastructure for safety is a necessary part of the larger Safe Systems approach.

Issues in equity are also paramount to consider in development and implementation of any road safety intervention, particularly across income and racial groups (Elvik, 2009). For example, while the model in this study indicated the largest injury avoidance benefits could be achieved from increased seat belt fines and high visibility enforcement campaigns, the impact of this policy change on low income communities should be considered. Members of these communities are less likely to have vehicle technology that improves seat belt use (vehicle alerts) and greater difficulty paying fines. Further, studies have found evidence of racial disparities in traffic policing (Baumgartner et al, 2017). Several equitable approaches for seat belt citations are already in place in some US communities. For example, Oregon employs an alternative sentencing program, where violators receive waived or reduced fees if they attend a relatively more affordable course on seat belt use (Hedlund et al, 2008). Another alternative could be modeled after the day fine system utilized in countries such as Finland, where fine amounts are based on the violator’s income (Kantorowicz-Reznichenko, 2015). Numerous US cities (e.g., Chicago, Los Angeles, Austin) are actively considering

equity issues as they develop and implement their new road safety and Vision Zero plans. Additional research is warranted on equitable applications of road safety strategies.

Relatedly, speed cameras, third on the list of prioritized interventions for NC in terms of fatalities averted, could result in significant cost savings annually. As an automated enforcement method, speed cameras are more equitable as they catch all speeders regardless of the driver or type of vehicle. Automated enforcement has been successfully integrated into Vision Zero plans as a key strategy, with evidence of improvement in safe driving behaviors and reduced motor vehicle collisions in other countries, such as the UK and Spain (Li et al, 2013; Novoa et al, 2010), and have been shown to be effective in several US cities (Hu and McCartt, 2016; Retting et al, 2008).

Policy and intervention decision-making in an effective road safety system should include the collaboration of multiple agencies and fields, such as engineering, urban planning, public health, law enforcement, transportation, and policy makers. To achieve this, communities employing Safe Systems principles often establish coalitions consisting of leaders from different government agencies (e.g. departments of transportation and public health), nonprofit organizations, industry, and healthcare (Naumann et al, 2019). Creating systemic change requires each partner to bring their unique perspective to the table (McClure et al, 2016). Underutilized behavioral interventions and potential implementation within a holistic Safe Systems strategy have an important role to play in these discussions, plans, and resulting decisions and action in NC.

Limitations

While MV PICCS has a number of strengths, there are also some limitations. The version of the model utilized in this study (version 3.0) was developed using 2015 data, and therefore, any changes in intervention implementation and effectiveness after that date are not automatically reflected in the model results. While sensitivity analyses can be conducted to alter any of the model's parameters, this was not necessary for the present study. Additionally, quality of data used for analyzing effectiveness in terms of injuries prevented, and costs averted, will likely vary by policy and intervention. Therefore, model results should be used in conjunction with updated local assessments during decision-making. Finally, the model places emphasis on evidence-based interventions. Promising interventions that currently lack any evidence were not included, and these include a number of pedestrian safety interventions.

Conclusions

MV PICCS provides a useful model for exploring state-specific interventions that are currently implemented at an effective intensity, and identifying new and underutilized interventions that could benefit a state in terms of injuries prevented and costs averted. Analysis using the tool can be used as a starting point for addressing behavioral aspects of a safer road system. In NC, we found that with a hypothetical initial implementation budget of $1.5 million, seven evidence-based behavioral strategies could be integrated into statewide road safety efforts, to avert 16,067 injuries and 302 fatalities annually, with over $838 million in averted costs. We emphasize that these are estimated savings in injuries and costs.

While behavioral policies play an important role, comprehensive road safety plans should also include interventions targeting environment, vehicles, technology, and infrastructure. Additionally, when considering any road safety intervention, including those in MV PICCS, strategies should draw on multiple stakeholder perspectives and carefully consider equity issues.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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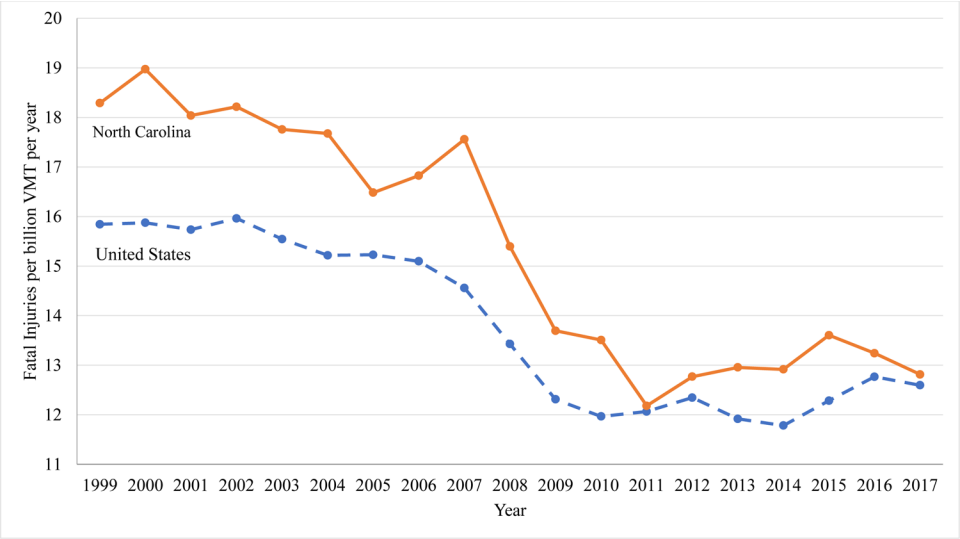

FIGURE 1.

Motor vehicle-related fatalities* per billion vehicle miles traveled (VMT) per year, North Carolina and United States, 1999 – 2017

*ICD 10 Codes: V02-V04,V09.0,V09.2,V12-V14,V19.0-V19.2,V19.4-V19.6,V20-V79, V80.3-V80.5,V81.0-V81.1,V82.0-V82.1,V83-V86,V87.0-V87.8, V88.0-V88.8,V89.0,V89.2, X82,Y03,Y32

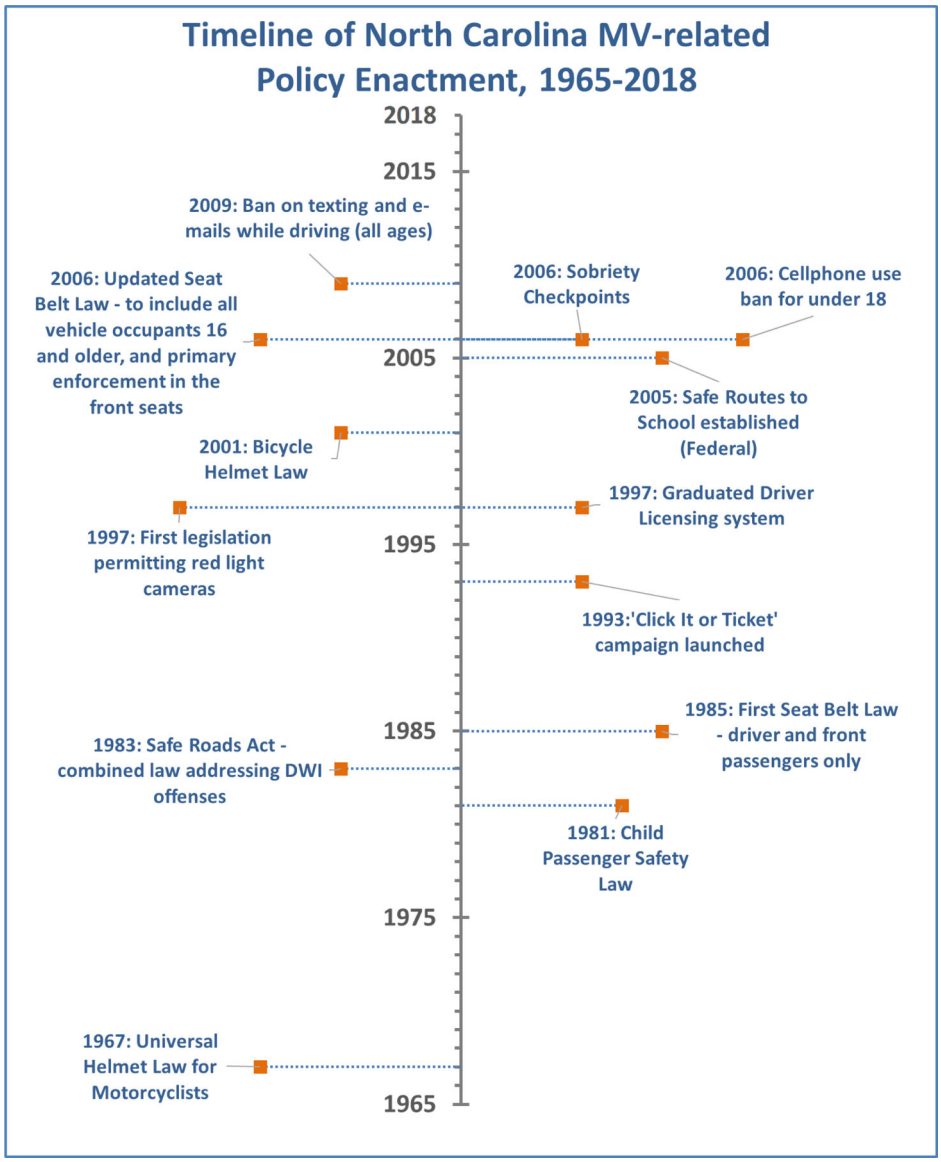

FIGURE 2.
Timeline of key North Carolina road safety-related policies, 1965–2018

Table 1.

Selected* evidence-based road safety policy/intervention definitions, as cited by MV PICCS, and current level of implementation in North Carolina

Evidence-based road safety policy/intervention	Definition and level of implementation
Alcohol Ignition Interlocks	Also known as ignition interlocks, these devices prevent a vehicle from starting until confirmation that the driver's blood alcohol content (BAC) is below the legal level (by blowing into a tube). This policy would require installation of interlocks in vehicles of repeat driving while impaired (DWI) offenders, including for all first-time offenders, regardless of BAC level. Currently, North Carolina utilizes these only under specific circumstances (repeat offenders and high-BAC first-time offenders).
Increased Seat Belt Fine	This adds $75 to the existing seat best fine. Currently, the penalty in North Carolina is $25.50 (and court costs) for driver and front seat passengers, and $10 (no court costs) for rear seat occupants.
In-Person License Renewal	This calls for drivers over 70 years of age to renew their driver's license in-person. Currently, North Carolina does not place any restrictions on license renewal procedures based on age.
License Plate Impoundment	This calls for drivers convicted of DWI to surrender their license plate (or have an 'invalid' sticker affixed to the plate), to deter DWI offenders from driving their vehicles. Currently, North Carolina utilizes these only under specific circumstances.
Limits on Diversion and Plea Bargaining	This requires limits on programs allowing DWI offenders to receive lighter sanctions or be diverted out of normal procedures, leading to greater numbers of DWI offenders being convicted of more serious charges. Currently, there are no limits on diversions or plea-bargaining in North Carolina; however, prosecutors must explain any reductions or dismissals of a DWI charge.
Saturation Patrols	This calls for more police officers in specific locations, to patrol for suspicious and/or impaired driving behavior. While these are currently legal and utilized in North Carolina, a greater frequency of such patrols would increase effectiveness.
Seat Belt Enforcement Campaign	Policy utilizing intense enforcement with a high-visibility publicity campaign over a short and fixed period of time, with an emphasis on restraint use. North Carolina first implemented its 'Click It or Ticket' in 1993. However, research shows that most states do not implement these campaigns at an optimal intensity for significant impact on road-user safety. Therefore, states could consider increasing the frequency and/or intensity of these campaigns.
Speed Camera	Captures image of driver's vehicle and license plate when they are traveling above the speed limit. Currently, speed cameras are not utilized in North Carolina.
Vehicle Impoundment	This requires confiscation of vehicles belonging to DWI offenders for a period of time. Currently, North Carolina requires impoundment only under specific circumstances.

*Interventions were selected by the CDC and included in the MV PICCS model if they: (1) were intended to change driver or passenger behavior, as opposed to infrastructure, (2) could be implemented at the state level, (3) were found to be highly effective in the scientific literature, and (4) were not widely implemented by states across the country. The interventions defined in the box above are those that are either not implemented in NC or not implemented at the intensity specified in the tool (e.g., seat belt fine).

TABLE 2.

Potential annual fatalities, non-fatal injuries, and total costs averted from hypothetical implementation of evidence-based road safety policies and interventions not currently active in NC [*]

Potential Policies/ Interventions[†]	Fatalities Averted	Non-fatal Injuries Averted	Estimated Cost to Implement[**]	Estimated Fines and Fees	Estimated Net Cost to Implement[***]	Estimated Total Costs Averted[****]
Seat Belt Use						
Increased Seat Belt Fine	70	6,597	$0	$6,038,000	-$6,038,000	$256,791,000
Seat Belt Enforcement Campaign	52	4,948	$2,883,000	$801,000	$2,082,000	$191,788,000
DWI						
Alcohol Ignition Interlocks	15	217	$130,000	$0	$130,000	$29,038,000
Saturation Patrols	73	1,035	$10,719,000	$5,355,000	$5,364,000	$140,863,000
License Plate Impoundment	17	244	$724,000	$9,255,000	-$8,531,000	$32,868,000
Limits on Diversion	7	99	$30,439,000	$17,554,000	$12,885,000	$13,502,000
Vehicle Impoundment	19	274	$34,620,000	$28,678,000	$5,942,000	$36,763,000
Other						
Speed Camera	66	2,392	$9,814,000	$4,080,000	$5,734,000	$158,982,000
In-Person License Renewal	17	1,049	$739,000	$0	$739,000	$50,351,000
Adjusted total of prioritized interventions [Θ]	302	16,067	$25,010,000	$25,042,000	-$32,000	$838,844,000

DWI= driving while impaired

[*] Not implemented at all or not implemented at the level specified in the MV PICCS model (version 3.0)

[†] *Italicized items* were prioritized for implementation by MV PICCS, assuming an implementation budget of $1.5 million. Note: given a budget of $18.31 million with fines and fees included, all interventions could be implemented.

[**] Cost to implement represents total of all costs to implement the intervention, such as police time, equipment, etc.

[***] Net cost to implement represents net cost to state (cost of implementation minus estimated fines and fees).

[****] Total Costs averted of each intervention is derived by calculating costs per fatal and/or non-fatal injury in each state, and applying to total estimates of fatalities averted and injuries prevented from each specific intervention. See Table 3 for costs averted, stratified by payer.

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$^{\Theta}$Adjusted total of prioritized interventions considers related interventions with overlap in targeted drivers (e.g. alcohol-impaired drivers) and avoids double-counting costs and benefits. For cost averted categories, this was calculated using an estimated percentage by Blincoe et al., 2015

TABLE 3.

Estimated total and stratified costs averted from hypothetical implementation of evidence-based road safety policies and interventions not currently active in NC*

Potential Policies/ Interventions†	Potential Total Costs Averted**	Estimated Payer Source***				
		State and Local Government	Federal Government	Private Insurer	Self	Other
Seat Belt Use						
Increased Seat Belt Fine	$256,791,000	$7,703,730	$10,271,640	$138,667,140	$59,061,930	$41,086,560
Seat Belt Enforcement Campaign	$191,788,000	$5,753,640	$7,671,520	$103,565,520	$44,111,240	$30,686,080
DWI						
Alcohol Ignition Interlocks	$29,038,000	$871,140	$1,161,520	$15,680,520	$6,678,740	$4,646,080
Saturation Patrols	$140,863,000	$4,225,890	$5,634,520	$76,066,020	$32,398,490	$22,538,080
License Plate Impoundment	$32,868,000	$986,040	$1,314,720	$17,748,720	$7,559,640	$5,258,880
Limits on Diversion	$13,502,000	$405,060	$540,080	$7,291,080	$3,105,460	$2,160,320
Vehicle Impoundment	$36,763,000	$1,102,890	$1,470,520	$19,852,020	$8,455,490	$5,882,080
Other						
Speed Camera	$158,982,000	$4,769,460	$6,359,280	$85,850,280	$36,565,860	$25,437,120
In-Person License Renewal	$50,351,000	$1,510,530	$2,014,040	$27,189,540	$11,580,730	$8,056,160
Adjusted total of prioritized interventions Θ	$838,844,000	$25,165,320	$33,553,760	$452,975,760	$192,934,120	$134,215,040

DWI= driving while impaired

* Not implemented at all or not implemented at the level specified in the MV PICCS model (version 3.0)

† *Italicized items* were prioritized for implementation by MV PICCS, assuming an implementation budget of $1.5 million. Note: given a budget of $18.31 million with fines and fees included, all interventions could be implemented.

** Costs averted (Benefits) of each intervention is derived by calculating costs per fatal and/or non-fatal injury in each state (based on medical, emergency services, market productivity, household productivity, insurance administration, workplace costs, legal costs, travel delays, and property damage), and applying to total estimates of fatalities averted and injuries prevented from each specific intervention.

*** Cost averted categories (Government, Private, Self, and Other) were calculated based on national percentages provided by Blincoe et al., 2015

[θ] Adjusted total of selected interventions considers related interventions with overlap in targeted drivers (e.g. alcohol-impaired drivers) and avoids double-counting costs and benefits. For cost averted categories, this was calculated using an estimated percentage by Blincoe et al., 2015