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The **Transportation Research and Injury Prevention Programme (TRIPP)** at the Indian Institute of Technology Delhi, is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport. TRIPP attempts to integrate all issues concerned with transportation in order to promote safety, cleaner air, and energy conservation. Faculty members are involved in planning safer urban and inter-city transportation systems, and developing designs for vehicles, safety equipment and infrastructure for the future. Activities include applied research projects, special courses and workshops, and supervision of student projects at postgraduate and undergraduate levels. Projects are done in collaboration with associated departments and centres at IIT Delhi, government departments, industry and international agencies.

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THE CARE AND TRANSPORT OF TRAUMA VICTIMS BY LAYPERSON EMERGENCY MEDICAL SYSTEMS: A QUALITATIVE STUDY IN DELHI, INDIA

Bhalla, K., Sriram, V., Arora, R., Ahuja, R., Varghese, M., Agrawal, G., Tiwari, G. and Mohan, D.

In India and many low- and middle-income countries (LMICs), ambulance-based emergency medical systems (EMS) are uncommon. Over half of the global population lives in areas without formal EMS. Victims of traffic crashes in LMICs are typically transported from the crash scene to a hospital by bystanders and passing ethicles. In India, surveillance at medical facilities suggests that most victims are brought to hospital by taxis or police, with ambulances accounting for less than 5% of transport — a pattern that has shifted little in 30 years. Despite strong advocacy,the high equipment and operational costs of ambulance-based EMS suggests they will not be adopted or expanded to scale in many LMICs.

In principle, EMS aim to improve trauma outcomes by providing: (1) medical interventions in the field, and (2) rapid transport to a definitive care facility. However, evidence suggests that many prehospital interventions are ineffective and that the main benefits of EMS likely accrue from rapid transfer. Increasingly, studies have questioned the benefits of emergency endotracheal intubation,15 intravenous drug therapy, fluid resuscitation and spine immobilisation. In fact, studies show that trauma victims transported by advanced life support ambulances have similar or worse outcomes than basic life support, likely due to interventions that are poorly performed and which delay transfer to definitive care. Recognising the weak evidence for advanced training of first responders, the WHO recommends that LMICs should train lay responders, such as commercial drivers, to provide basic first aid and rapid transfer to hospitals. Several studies have reported training of commercial drivers, police, community leaders and others in LMICs.

The second key aspect of EMS — coordination of lay responders to reduce transfer time — has received very little attention in advocacy efforts. Although advanced communication networks have been previously viewed as expensive components of the most advanced systems, recent developments in smartphone technology have made coordinated taxi fleets common in LMICs. In fact, there have been several unsuccessful attempts to develop a 'layperson-EMS' by using peer-to-peer or dispatcher-coordinated networks of lay responders. For instance, in recent years, ridesharing companies in India (Uber in Hyderabad and Wagon Cab in Delhi) have launched emergency ride options. Similarly, some services have attempted to build dispatcher-coordinated networks of existing private ambulances (AMBER Health and LifeHover in Delhi, Dial242 in Mumbai, StanPlus, eSahai and Call Ambulance in Hyderabad). A review of the websites for these services suggest that few have sustained after the initial launch. This indicates that layperson-EMS may face legal,medical and social barriers that need to be systematically addressed.

In 2017, researchers at the University of Chicago and the Indian Institute of Technology (IIT) Delhi initiated a project funded by the US National Institutes of Health to assess the feasibility of developing a coordinated system of lay first-responders that could improve population-level outcomes of traffic crashes in Delhi, India. One aspect of the project aimed to understand how trauma victims currently access medical care, and the barriers to such a system being formalised into a coordinated layperson-EMS. In particular, we sought to understand the following aspects from the perspective of frontline stakeholders, policymakers and experts: (i) who helps victims, (ii) how are they transported to hospitals, (iii) what deters help from good Samaritans, (iv) how can these barriers be addressed and (v) could a layperson-EMS improve outcomes. In this paper, we report our findings and share recommendations for EMS policy in Delhi and similar settings.

Delhi is the capital of India and has an estimated population of 20 million. It has a complex administrative structure, with federal, state and local government agencies overseeing various aspects of governance. For example, while Delhi Police is overseen by the federal government, health services are primarily administered by the state government. Delhi's formal EMS consists of a public ambulance service with a fleet of 265 ambulances (31 Advanced Life Support, 110 Basic Life Support and 124 Patient Transport) but it is common for emergency transport to be provided by police, taxis (especially auto rickshaws) and private vehicles.41 42 Healthcare in Delhi is provided by a mix of for-profit hospitals, and relatively low-cost public hospitals. Patients often leave for-profit hospitals against medical advice for financial reasons. It is standard medico-legal practice across India to treat all injuries as potentially criminal cases that are registered as medico-legal cases and reported to the police. Surveys suggest that the fear of getting entangled in long-drawn legal processes deters bystanders from helping traumavictims.46 47 In 2014, following public interest litigation, the Supreme Court of India instructed the federal government to develop legislation to protect good Samaritans and compel for-profit hospitals to stabilise victims and provide first aid. Subsequently the government issued an executive order to this effect ('Good Samaritan Notification'). We used qualitative methods to elicit viewpoints of five groups of stakeholders — (1) drivers of taxis (three-wheeled auto rickshaws and four-wheeled taxis), (2) medical personnel (doctors, nurses and hospital administrators), (3) legal experts, (4) police personnel and (5) other stakeholders (including policymakers, ambulance providers, non-governmental organisations (NGOs), hospital stretcher bearers and security guards and public health researchers). We acquired research data through: (i) Key informant interviews (ii)Sampling.

We used a combination of purposeful sampling techniques. All respondents had experience with transport, medical or legal aspects of trauma either as professional practitioners or through policy engagement (criterion sampling). We relied on recommendations from interviewees to identify additional respondents (snowball sampling), and used convenience sampling to identify certain taxi drivers and medical personnel. We designed interview guides to understand respondents' experiences and viewpoints towards emergency transport, barriers to bystander assistance and a coordinated layperson-EMS. The guides were informed by preliminary discussions with a sample of stakeholders prior to data collection. We refined and added questions as data collection progressed. In order to anchor reactions about a coordinated layperson-EMS, we presented respondents with a hypothetical taxi-EMS consisting of a fleet of taxis with drivers trained in first aid and dispatcher-coordinated using a smartphone application (app). When an emergency call is received at the control room and no ambulance is available, the taxi closest to the crash site is recruited through the app. The app provides navigation to the crash site and the closest participating hospital, where the driver is paid for their effort using mobile-to-mobile cash transfer.

Four researchers (RA, RAr, KB, VS) with backgrounds in transportation, engineering and/or public health collected data during December 2017 to March 2019. Two researchers had training in qualitative methods (VS,RAr), while one underwent a short training in qualitative methods before the project began (RA). We conducted 50 interviews (26 recorded), typically lasting 45 to 60 min, in Hindi, English or a combination. These included five short interviews (<15 mins) with individuals with knowledge about a specific topic but who were not suitable for full length interviews. We took handwritten notes, which were typed and stored electronically.

Stakeholder consultation: Halfway through data collection (June 2018), we held a stakeholder workshop to share emerging ideas and get feedback. The workshop had 16 external participants in addition to seven from our team, and included legal experts, academic researchers, government bureaucrats, ambulance administrators, physicians and senior police personnel. We took notes which informed our data collection and analysis.

Document review: Thirty-six documents were reviewed to gather information on legal judgements, national and state policies and operational procedures. Documents were identified through internet searches and discussions with participants.

Drawing on principles from general thematic analysis,51 recorded interviews were transcribed by a contracted transcriber, and cleaned and checked by a team member (RA). We combined deductive and inductive approaches in the process of developing the codebook, using some predefined codes and

allowing others to emerge during coding. We first applied the draft codebook to three transcripts, and further refined the codes. Next, two of the four coders (RA, RAr, VS, KB) coded all transcripts and notes. We consolidated our coding in NVivo and partitioned the data. Team members reviewed the coded data and developed early themes. Two members (KB, VS) further refined the themes, and finalised them after discussion with the entire research team. We strengthened data quality by: (1) Triangulation — we discussed concepts across stakeholder categories and cross-checked respondent statements with key documents; (2) Prolonged engagement — we spent 14 months collecting data at regular intervals, allowing us to develop a deeper understanding of the topics; (3) Peer debriefing — we had regular group meetings throughout the research process and (4) Respondent validation through a stakeholder consultation.

Our study was underpinned by a constructivist epistemology, where our goal was to capture the perspective of respondents, many of whom held different viewpoints. However, we also attempted to gain a positivist understanding of relevant processes. The research team was multidisciplinary, and we had regular discussions on epistemological approaches and the impact of these different approaches on data collection and interpretation.

India is in the midst of making substantial changes to national health and transportation policies, and improving trauma outcomes is the focus of significant policy dialogue. In the last few years, there has been extensive advocacy from NGOs, Supreme Court judgements, executive orders and substantial national and international news coverage focused on improving access to care for trauma victims. Our study provides important insights relevant to this dialogue by providing a rich description of what happens to trauma victims in the field, at hospitals and in the medico-legal system. In the discussion that follows we highlight key legal, medical and social issues, focusing specially on implications for a layperson-EMS.

In India, deeply entrenched medico-legal practices force good Samaritans into extended and often onerous interactions with police. Surveys suggest that over half of law-abiding Indian citizens fear the police, and our results illustrate why. Our respondents shared many anecdotes where good Samaritans were coerced into being witnesses, held against their will or much worse, wrongfully implicated in causing the crash. Furthermore, medical professionals dislike adhering with medico-legal practices because they interfere with patient care.

India's recent Good Samaritan Notification tries to circumscribe allowable police practices but our findings suggest that the Notification appears not to have affected medico-legal processes substantively. This is likely because the executive order doesn't stop police from questioning witnesses, and the most irksome police practices, such as coercing testimony, were already illegal. The Notification also instructs local governments to give rewards to bystanders, which pale in comparison to the medico-legal burdens. This may explain why only 4% of good Samaritans who helped trauma victims have claimed the financial incentive of rupees 2000 (~$30) being offered by the Delhi government.

While WHO recommends that countries establish legislations that protect good Samaritans, our study highlights that the issues and legal remedies will likely vary based on country-specific conditions. Globally, good Samaritan laws are typically framed as either duty-to-assist or protection-against-liability, which may not make sense in many LMICs. Consider, for instance, that good Samaritan laws in the USA successfully helped alleviate physician concerns that they would be sued for malpractice if they helped at accident sites. However, China's new law protecting good Samaritans from the liability of exacerbating injuries fails to address their main concern of being implicated of causing the accident. Thus, it is important that LMICs assess their particular situations and evolve appropriate countermeasures for protecting good Samaritans. For our specific example, protecting taxi drivers against police harassment would likely require the taxi-EMS to have official police sanction, and the taxis to carry visible symbols (eg, medallions or certificates) of their authority to provide emergency transport.

Although a layperson-EMS aims to address transportation barriers, our findings highlight other important sources of delays in India's healthcare system. Notably, care at for-profit hospitals is often delayed until it is established that somebody will pay for victims who may be poor, unaccompanied and/or disoriented. Although an amendment to the Motor Vehicles Act has required all hospitals to stabilise patients since 1994, our respondents described many anecdotes of how for-profit hospitals sidestep requirements. Such practices will likely continue until there is a mechanism for hospitals to recoup costs, such as through no-fault universal health coverage, as recommended by the Sustainable Development Goals. India is in the midst of major legislative and policy reforms to its healthcare and motor vehicle insurance sectors, whose implementation could create such a financial mechanism. However, until it is established that for-profit hospitals reliably provide care, good Samaritans should take victims with uncertain financial means to public hospitals. For a layperson-EMS, this likely means transporting to hospitals that have agreed to participate and have the requisite capacity.

Our findings suggest that a layperson-EMS could face opposition from various stakeholders. The underlying rationale for a layperson-EMS is that rapid transfer to hospital is of overriding importance for improving outcomes. Although our senior medical respondents understood this well, junior medical respondents commonly expressed concern about exacerbating spinal injuries. Similar apprehensions were also raised by some of our non-medical respondents. Although such concerns are likely overstated, the social acceptability of a layperson-EMS will likely require its medical legitimacy to be accepted by the public.

Social class issues were the subtext of many reactions to our proposed taxi-EMS. Often these took the form of a strong bias against the vehicle (especially auto rickshaws) and the entrenched class hierarchies of cities such as Delhi, but also concern of whether taxi drivers were responsible actors who would be trusted by, for instance, pregnant women. Regardless of whether such apprehensions have merit, ensuring social acceptability of a taxi-EMS may require that the system is viewed as a semi-professional operation with visible symbols of authority to act in an emergency, and with trained drivers who appear to be following a prescribed protocol.

Our study finds that Delhi already has key EMS components that could potentially be integrated and expanded into a complete system of emergency care. Notably, our study highlighted that the police in Delhi already transports trauma victims to hospital as a routine part of operations. In effect, they respond to accidents like a coordinated non-medical EMS, with a control room and dispatch protocols, fleet of vehicles equipped with first aid and victim transport capabilities, providers with rudimentary training and empanelled hospitals. In fact, contrary to a popular belief that trauma victims face large delays in getting to hospital, many of our frontline stakeholders noted that most severely injured victims in Delhi are already transported rapidly by police. Partly for this reason, they tended to view the taxi-EMS as an additional component to police operations intended for less severely injured victims. Although the use of equipped police vehicles to transport trauma victims is unique to Delhi, dispatcher-coordinated police operations are common in many major urban centres in India,65 and likely, globally. If these capacities can be extended to emergency transport, they may provide LMICs a cost-effective pathway to coordinated EMS.

Delhi's coordinated police response, as well as our hypothetical taxi-EMS, focus primarily on accidents. However, traumatic injuries only accounts for about one-fifth of all emergency health conditions. Our senior respondents noted that it would be unethical for an EMS to not respond to all health emergencies. Although it is unclear how much the mandate of a police-based operation can be expanded to incorporate other medical services, it may be possible to efficiently link it with other services. Delhi's police already contact the Centralised Accident and Trauma Services public ambulance system, which is often unable to meet demand. However, the supply of ambulances in the EMS could be dramatically increased by including private ambulances, which are commonly available in Delhi but used primarily for inter-hospital transfers. Other governance challenges associated with developing a coordinated system in Delhi include its unique political system (Delhi's governance is shared between the federal government, Delhi's state government and four municipal governments, and the broader National Capital Region includes two other states with their own ambulance systems). Thus, other LMIC settings interested in developing an EMS should assess their current situation of prehospital transport and the availability of existing components of an EMS system that may be integrated and expanded.

Excerpts from:

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Excerpts from three publications: A TRIPP BULLETIN INSERT

Modelling Vehicular Behaviour Using Trajectory Data Under Non-lane Based Heterogeneous Traffic Conditions

The present study aims to understand the interaction between different vehicle classes using various vehicle attributes and thereby obtain useful parameters for modelling traffic flow under non-lane based heterogeneous traffic conditions. To achieve this, a separate coordinate system has been developed to extract relevant data from vehicle trajectories. Statistical analysis results show that bi-modal and multi-modal distributions are accurate in representing vehicle lateral placement behaviour. These distributions help in improving the accuracy of microscopic simulation models in predicting vehicle lateral placement on carriageway. Vehicles off-centeredness behaviour with their leaders have significant impact on safe longitudinal headways which results in increasing vehicular density and capacity of roadway. Another interesting finding is that frictional clearance distance between vehicles influence their passing speed. Analysis revealed that the passing speeds of the fast moving vehicles such as cars are greatly affected by the presence of slow moving vehicles. However, slow moving vehicles does not reduce their speeds in the presence of fast moving vehicles. It is also found that gap sizes accepted by different vehicle classes are distributed according to Weibull, lognormal and 3 parameter log logistic distributions. Based on empirical observations, the study proposed a modified lateral separation distance factor and frictional resistance factor to model the non-lane heterogeneous traffic flow at macro level. It is anticipated that the outcomes of this study would help in developing a new methodology for modelling non-lane based heterogeneous traffic.

In developing countries such as India, vehicles do not follow lane discipline and they always deviates from center-line positions. In addition disruptive lane changing can also be observed. In addition, the complexity in traffic flow also increases due to het-erogeneous vehicle-driver units and their complex interactions.

Due to the complexity of Non-Lane based Heteroge-neous Traffic system (NLHT), a detailed examina-tion of vehicle interaction is required. Further it is necessary to identify suitable parameters to build macroscopic continuum models for non-lane sys-tem. In this paper, an exploratory and confirmatory data analysis is performed to examine the vehicle trajectory data. Important vehicle characteristics such as lateral placement on carriage way, effective gap size distribution, relationship between longitu-dinal headways and lateral separation distance, moreover the dependency between vehicle passing speed and lateral clearance of vehicles are studied. Further, based on the observations, the study also in-troduced new macroscopic parameters to model non-lane systems using continuum theories. This study helps in understanding the vehicle interactions in mixed traffic and can be used for developing new macroscopic continuum methodology for modelling heterogeneous traffic in non-lane based systems.

Vehicle behaviour in non-lane based heterogeneous traffic stream significantly deviates from homogene-ous traffic stream. The typical behaviour of vehicles in NLHT can be best explained by staggered vehicle movement, lane sharing, varying physical dimen-sions and diverse dynamical characteristics. Due to their distinct behaviour, they may increase or de-crease the capacity of the traffic facility. One of the unique features of the NLHT stream is that they uti-lise the road width very effectively without compro-mising their desired speed.

In this study, exploratory data analysis was done to understand the behaviour of heterogeneous traffic using the following attributes:

(i) Selection of lateral lane position (LP) by different vehicle classes across the carriage way.

(ii) Relationship between longitudinal headways (LH) and lateral separation distances (LSD).

(iii) Relationship between vehicle passing speed and lateral clearance.

(iv) Finally, the distributions of effective roadway width (sum of vehicle width and frictional clearance on both sides) required for the vehi-cle classes to move downstream.

The coordinate system and the method of data collection used in this study. The analysis has been done for the data collected at or near-capacity condition where vehicles start interacting each other and sufficient deviation in speeds can also be observed. Terminologies such as non-lane based traffic and mixed traffic are interchangeably used in this paper to rep-resent the traffic streams in NLHT.

Following are the conclusions from this study:

- In non-lane environment, vehicles lateral posi-tions on carriageway depend on their ease of movement, physical and dynamical characteristics. The study suggests that the use of bi-modal and multi-modal distributions in representing lat-eral placement characteristics of vehicles will im-prove the modelling accuracy.

- Safe longitudinal headways maintained by vehi-cles decrease due to their off-centered behaviour. This behaviour leads to reduction in the critical gaps maintained by vehicles. In other words, it in-creases the density of the road way section. Car following models suggested by Jin et al. (2010) and Li et al. (2015) can be taken as basis to incorporate off-centered behaviour of the vehicles into macroscopic continuum model.

- Another interesting outcome of this study is that frictional clearance distance between vehicles in-fluence their passing speed. Based on empirical observations, parameters such as lateral separation distance factor and frictional clearance factor were introduced to study the behaviour of non-lane heterogeneous traffic flow at macro level.

- It is interesting to note that vehicles maintain closer headways with MTW's. Hence, high proportion of MTW's increases the density and capacity of the traffic stream. However, heavy vehicles such as buses act like a moving bottle-necks, thereby reducing the critical density, jam density and capacity of the traffic stream.

- The two new concepts proposed in this study such as modified lateral separation distance factor and frictional clearance factor can be used in the de-velopment of non-lane based heterogeneous con-tinuum models.

Hari Krishna Gaddam, K. Ramachandra Rao. Archieves of Transport, (2019), 52(4), 95-108.

Pedestrian accessibility and safety around bus stops in Delhi

We studied the accessibility of pedestrian infrastructure around ~360 sampled bus stops in Delhi by conducting physical audits. 15 indicators in the audit checklist were meaning fully reduced to five factors through Principal Components Analysis. We developed Poisson regression models (with their geographically-weighted counterparts) to assess the association between these five factors for each bus stop with the number of pedestrian fatalities around that stop. Two models were developed— a) for fatalities where the impacting vehicle was known, and b) for fatalities where the impacting vehicle was unknown (hit-and-run cases). For both the models, geographically-weighted Poisson regression (GWPR) performed better than their global Poisson counterparts. Overall improved access was seen to be positively associated with less pedestrian fatalities. Further, we established that the nature of hit-and-run cases differ from those where the impacting vehicle is known, through— a) difference in the effect of the exposure variable, b) different factors being significant in the respective models, especially in the GWPR. The novelty of this study is that we modelled the relationship of pedestrian fatalities around PT stops with factors related to the pedestrian access to these stops. Through the application of GWPR, we found that different types of pedestrian fatalities are related to different aspects of access. We also identified bus stops with higher risk of pedestrian fatalities. Based on this, the methodology presented in this study is useful in guiding city authorities to identify and prioritise a) specific access-related factors which require improvement, and b) bus stops which require improvement in their pedestrian-access infrastructure. These analyses can be extended to study pedestrian safety around PT stops in any city.

We estimated the number of bus stops with higher risk corresponding to each factor it was associated with, for both the models. Bus stops with significantly higher risk, and which are common to both the models, are presented. It should be noted that only 34 of 360 bus stops (9.4%) are of high-risk in both the models.

Continued overleaf

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Majority of these bus stops are located near arterial roads, or in the New Delhi area, which have adverse traffic conditions of high speed and large volume. Further, the pedestrians around these bus stops experience more time to cross the road, presumably due to the adverse traffic conditions, and hence, higher risks are associated with these. A few bus stops are also located near the southern periphery of Delhi, away from the arterial roads, indicating the lowquality of pedestrian infrastructure in peripheral areas of the city, found to be associated with high risk for pedestrian fatalities.

The strength of this study is that we have modelled the relationship of pedestrian fatalities around PT stops with indicators related to the pedestrian access to these stops.We simplified and meaningfully reduced a large number of these indicators into five factors, and established that pedestrian fatalities are related to different aspects of access. We also established that the nature of pedestrian fatalities where the impacting vehicle is known is different from hit-and-run cases. This was also substantiated by the factors having different associations in the two models.

Through the application of the GWPR models, we were able to identify bus stops with significantly higher risk of pedestrian fatality, and also which factors were significant for these bus stop locations. The findings establish that improving pedestrian infrastructure is likely to be associated with less pedestrian fatalities.

We conclude that improved access is associated with fewer pedestrian fatalities, which is in agreement with universal knowledge. However, the originality of our research contribution is three-fold. Firstly, the novelty of our approach is that pedestrian safety around PT stops has been studied as a function of the quality of access to the stops, and different models were found to be appropriate to distinguish between fatalities where impacting vehicle is known versus hit-and-run cases.

To our knowledge, the association between number of pedestrian fatalities and pedestrian-access-related factors (determined empirically through application of Principal Components Analysis) has not been found in prior studies, especially for Delhi. Further, the methodology presented in this study is useful in assisting city authorities and urban practitioners to identify which specific factors or indicators related to access require improvement on a priority, as well as, in identifying which locations require interventions on a priority. On this basis,we advocate that if city-level policies and directives focus on improving the quality of the PT infrastructure, we will likely reduce city-wide pedestrian fatalities also as a direct consequence.

Sneha Lakhotia, Sylvain Lassarre, K. Ramachandra Rao, Geetam Tiwari . IATSS Research 44 (2020) 55–66

Preventing motor vehicle crash injuries and deaths: science vs. folklore lessons from history

Not long after the beginnings of motorization in the early 1900s, deaths and injuries from motor vehicle crashes became a problem in a number of high-income-countries (HIC)s, especially the United States. With the biggest problem the US led early efforts to address this issue, and for six decades these efforts were based on folklore (ie a body of widely held but false or unsubstantiated beliefs). They were not evaluated, but clearly were unsuccessful as crash deaths and injuries continued to rise. It was not until the 1970s that a broader range of countermeasures began to be adopted and was scientifically evaluated, and as a result, crash deaths and injuries declined. This history has important lessons today for many low-and-middle-income countries that have growing numbers of motor vehicle crash deaths and injuries, many of which are pedestrians and motorcyclists. This is because there continue to be advocates for many of the failed approaches (especially educational) that dominated the early efforts in HICs.

First and foremost, all countries should have a broad range of countermeasures aimed at reducing motor vehicle crash injuries and deaths, and they should also have in place data systems, which facilitate evaluations of these programs. There are, however, some important differences between HICs and LMICs, in particular, many LMICs have much more heterogeneous traffic mixes with proportionately many more vulnerable road users than typical HICs. These different, and often complex, traffic mixes may make some approaches that have been successful in HICs inappropriate for some LMICs.

In 2015 in the US 64% of the deaths were occupants of passenger vehicles, 15% were pedestrians, and 13% were motorcyclists. In contrast in the same year in India, cars, vans, and other light motor vehicles accounted for estimated 7% of the deaths, motorized two wheelers for 34% and pedestrians 33%.

The four largest motorcycle markets in the world are all in Asia: China, India, Indonesia, and Vietnam.18 Motorcycle ownership in many African and South American countries is also increasing and as result, fatalities involving motorcycles are increasing.

In a number of Asian countries there are also unique vehicle types that do not exist in HICs, for example tuktuks in Thailand, jeepneys in Philippines, and three-wheeled scooter taxis in India. Obviously, such vehicles are not especially crashworthy, however, these vehicles have low fatality rates for their occupants, and 'are probably the most efficient taxi invented for urban areas.

One of the reasons for low fatality rates for such vehicles in India and elsewhere could be that they have low powered engines (usually <175 cc) and so they cannot be driven at speeds greater than about 50 km/h and lower when overloaded.

Despite the overwhelming evidence that education by itself does not work, there are still advocates who continue to promote educational approaches. Changing road user behaviour is important, however, and as in HICs this can be accomplished most effectively by traffic laws that are enforced. The high use of motorcycles and scooters in many LMICs, indicates that enacting and enforcing helmet use laws should be a high priority in many LMICs.

When it comes to passenger vehicle countermeasures, LMICs with unique low speed vehicles such as tuk-tuks should be developing appropriate standards (based on the death and injury patterns for such vehicles) so that there are some appropriate minimum levels of safety for these vehicle types.

For conventional passenger vehicles, it is tempting to suggest that LMICs should adopt the motor vehicle safety standards of HICs; however, the reality is this could mean settling for safety levels that are far below the state-of-the-art. This is because NCAP programs have been able to accelerate safety improvement faster and significantly beyond the minimum levels specified by government standards.

It is not feasible for many LMICs to implement their own NCAP type programs, so what can LMICs do to improve the safety of vehicles in their markets? Since there are NCAP programs all over the world today, LMICs without such programs could try to piggyback on nearby programs by arranging for tests of vehicles being sold in their countries and, when appropriate, highlighting the safety deficiencies identified by the tests.

Traffic engineering countermeasures may pose the biggest challenges for LMICs because of the much more heterogeneous traffic than in HICs. Thus, where feasible, modern roundabouts should replace signalized intersections, and automated enforcement should be implemented. Roadside hazards should be eliminated on existing high-speed roads. However, much more research needs to be done to identify appropriate designs for roads with high proportions of vulnerable road users, as well as for stretches of rural roads and highways passing through highly populated areas.

In closing, LMICs should learn from the experiences of HICs and not waste resources on ineffective educational efforts as HICs did for decades, but instead look at successful countermeasures (as determined by scientific evaluations) and where appropriate apply them, with appropriate modifications for local conditions, and most importantly evaluate them for effectiveness.

Brian O'Neill & Dinesh Mohan. International Journal of Injury Control and Safety Promotion. (2020), VOL. 27, NO. 1, 3–11
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