

# **ECALL – DEFINING ACCIDENT CONDITIONS FOR MANDATORY TRIGGERING OF AUTOMATIC EMERGENCY CALLS**

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## **ABSTRACT**

eCall, the pan-European automatic crash notification system, will facilitate road vehicles to contact emergency services autonomously when a potentially injurious crash has been detected by vehicle sensors. Type-approval requirements will set out conditions for assessing systems under which automatic triggering of eCalls will be mandatory. Research is needed to specify the accident typologies and severities represented by these conditions.

This paper analyses what definition of accident conditions would ensure that a high number of casualties benefit from automatic eCalls. The conditions should also allow cost-effective type-approval testing, avoid excessive numbers of superfluous eCalls, and not restrict manufacturer's design freedom.

Two conditions were considered as being particularly suitable for the European type-approval system:

- Condition A: Trigger in accident conditions similar to, and at least as severe as, a mandatory frontal or lateral full-scale crash test.
- Condition B: Trigger in conjunction with deployment of any airbag.

In-depth accident data from the Road Accident In-Depth Studies (RAIDS) database, collected between 2000 and 2010 for the Co-operative Crash Injury Study (CCIS), was analysed to produce an estimate of the proportion of car occupant casualties captured by each of these conditions and subsequently scaled to a national level for Great Britain.

The analysis found that Condition A captured only 34.7% of fatally and seriously injured casualties whereas Condition B would apply to 81.0%. For Great Britain, with about 9,335 fatally or seriously injured car occupants annually, this is a difference of 4,330 fatal or serious casualties which could benefit from automatic eCall triggering each year. However, if Condition B was applied, automatic eCalls would be triggered for 74,390 slight casualties per annum in GB (and for an additional unknown number of damage-only accidents).

The sensitivity of Condition B, i.e. the proportion of casualties successfully selected, is considerably higher compared to Condition A. Nevertheless, accident types where airbags are deliberately not deployed would not be captured. Condition B exhibited an almost unvaryingly high sensitivity in selecting fatal casualties and serious casualties respectively.

The higher sensitivity of Condition B is achieved at the expense of specificity in selecting fatal or severe casualties, i.e. more of the collisions for which an eCall is triggered would be slight casualties. There are indications, however, that the negative consequences of superfluous eCalls could be mitigated.

The results are based on British data and cannot be transferred in detail to other countries. The general trends identified would be expected to also appear in reproductions of this analysis using data from other European countries.

The most preferable mandatory automatic eCall triggering condition for type-approval legislation appears to be triggering in conjunction with deployment of any airbag. Nevertheless, up to 19.0% of fatal and serious car occupant casualties might not be captured by this condition. To allow this problem to be overcome using advanced triggering algorithms, a non-restrictive approach could be taken with regard to the triggering requirement, i.e. require triggering in the presence of the condition yet not prohibit triggering in its absence.

## **INTRODUCTION**

### **eCall and the Associated Regulatory Process in the European Union**

eCall, the pan-European accident emergency call system (AECS), will facilitate road vehicles to contact emergency services autonomously when a potentially injurious crash has been detected by vehicle sensors. The in-vehicle system (IVS) will contact a public safety answering point (PSAP) via the pan-European emergency number 112. Once the connection is established, it will transmit a minimum set of data (MSD), containing information such as the exact location of the accident and the vehicle involved, and open a duplex voice channel to allow communication between vehicle occupants and PSAP operators. Shortly after the accident, emergency services therefore know that there has been an accident, and where exactly it occurred and can request additional detail, if needed, from the occupants. The safety benefit of eCall arises through the potential reduction in response times for emergency services attending to the accident, thus helping to treat injuries more rapidly which can contribute to a reduced probability of death in road accidents (Sánchez-Mangas et al. 2010).

The European Commission (EC) has adopted a proposal in June 2013 to make eCall mandatory for passenger cars in the near future (European Commission 2013). This was followed in February 2014 by the European Parliament's Legislative Resolution (European Parliament 2014). The subsequent Council's General Approach from May 2014 sets out the high level expectation with regard to the automatic triggering of eCall systems in Article 5.2 (Council of the European Union 2014): An eCall shall be triggered automatically "*in the event of a severe accident, detected by activation of one or more sensors or processors within the vehicle*". This expectation awaits translation into specific requirements for minimum triggering conditions that ensure effective system performance in passenger cars.

The objective of this study is, therefore, to assess the suitability of different accident condition definitions as minimum triggering conditions for type-approval requirements to ensure a high number of casualties benefit from automatic eCalls, while avoiding excessive numbers of superfluous eCalls and fulfilling constraints for implementation in type-approval legislation.

### **Review of Accident Conditions in Discussion for Automatic Triggering**

As reported in (Carroll et al. 2014), a review of international legislation, technical standards, cost-benefit studies and international voluntary system implementations provided a selection of different accident conditions for automatic triggering.

The set of European technical standards with regard to eCall does not set out specific mandatory triggering conditions. prEN 16454 Sections 9.4.9 and 9.4.10 refer to full-scale crash tests according to UN Regulation No. 94 (UN R94; frontal impact protection) and UN Regulation No. 95 (UN R95; lateral impact protection) to define shock resistance requirements. Section 9.4.11 defines a test to demonstrate that the automatic trigger is activated by different crash types. However, these sections do not provide any stipulation as to whether triggering should activate the automatic eCall during UN R94 or UN R95 crash tests or any other crash types, but simply that it performs in accordance with the manufacturer's intention.

Studies have been performed by McClure & Graham (2006), Stevens & Hopkin (2010), the European Commission (2011) and Hayden (2014) to determine the costs and benefits of a mandatory implementation of pan-European eCall. These studies did not report the specific triggering conditions used for the underlying benefit calculations and do therefore not constitute a source of accident conditions to assess for the present study.

The European Union (EU) is also involved in the legislative process at the UN level through the Informal Working Group on Automatic Emergency Call Systems (IWG AECS) under the Working Party on General Safety Provisions (GRSG) within WP.29 (1958 Agreement). The draft UN Regulation on AECD/AECS sets out the expectations with regard to automatic triggering in Part III, Section 24.2.2: An automatic call shall be triggered at least by the "*occurrence of a frontal collision according to Regulation No. 94 (frontal collision); or occurrence of a lateral collision according to Regulation No. 95 (lateral collision)*". In order to simplify type-approval, the EU is aiming to keep the European legislation closely aligned with Regulations under the 1958 Agreement (CARS21, 2012). Therefore, the triggering conditions proposed at the UN level are considered in this study as a possible option for EU legislation.

The upcoming mandatory AECS implementation of the Russian Federation, ERA-GLONASS, will reference the technical standard GOST R 54620, which sets out that automatic triggering must occur "*in the event of an accident in which there is a substantial likelihood of threat to life and health of people in the vehicle*". This is further detailed to include front-, side- and rear-impacts. The exact triggering conditions are left to the manufacturer's discretion; however, it is recommended to trigger an automatic call if the acceleration severity index (ASI) of a collision event exceeds a certain score. The ASI algorithm is commonly used as a vehicle-based way to predict the likelihood of injuries in full-scale roadside barrier tests because these are performed without crash test dummies. It is not deemed a suitable mandatory triggering condition for the present study: Given the development effort and complexities surrounding modern crash sensors in vehicles, the prescription of a specific algorithm is not considered suitable for European type-approval legislation with regard to the design freedom of vehicle manufacturers.

Voluntary implementations of AECSs exist in many world regions, including Japan, the United States of America (USA) and the EU. The Japanese implementation, HELPNET, links the automatic triggering of emergency calls to accidents where an airbag was deployed (IWG AECS-Representation of Japan 2014). The American voluntary AECSs are expected to also rely mainly on deployment of an airbag (Kononen et al. 2011). As to the voluntary systems in the EU, it was inferred from communications with vehicle manufacturers that, again, airbag deployment was an important condition for automatic triggering. Therefore, the condition of airbag deployment for automatic triggering forms the second option investigated as legislative triggering condition.

## METHODS

### Data Sources

Two sources of road casualty data were used, the UK's detailed Road Accident In-Depth Studies (RAIDS) database and the British road casualty database, referred to as STATS19. The in-depth accident data were used to identify the proportion of casualties where automatic eCalls were likely to have been initiated under certain definitions of accident conditions for automatic triggering. The RAIDS data were scaled to British national casualties with respect to injury severity using STATS19 data.

**RAIDS** RAIDS is one of the most comprehensive in-depth accident studies in the world; it is funded by the UK Department for Transport (DfT) to provide an evidence source to help prevent future road collisions and mitigate the injuries suffered. RAIDS pulls together four separate historical studies that ran from 1982 to 2010 into one database, including the Co-operative Crash Injury Study (CCIS). RAIDS currently collects information on approximately 500 accidents per year.

The CCIS project collected in-depth real world car occupant injury data from 1983 to 2010. Vehicle examinations were undertaken at recovery garages several days after the collision. Car occupant injury information was collected from hospitals and HM Coroners and questionnaires were sent to survivors. All injuries were coded using the Abbreviated Injury Scale (AIS) 1990 Revision (AAAM 1990). Accidents were investigated according to a stratified sampling procedure, which favoured cars containing fatal or seriously injured occupants as defined by the British Government definitions of fatal, serious and slight. Fatal injury includes only casualties who died less than 30 days after the accident, not including suicides or death from natural causes. Serious injury includes casualties who were admitted to hospital as an in-patient. Slight injury includes minor cuts, bruises, and whiplash. The CCIS project also favoured newer vehicles.

**STATS19** STATS19 is the database of all police reported injury accidents on public roads in Great Britain (GB). About 50 fields are recorded for each accident, including details of the accident circumstances, any vehicles involved and the resulting casualties. Driver and passenger casualties are linked to the vehicle that they were in or on at the time of the accident and pedestrian casualties are linked to the vehicle which hit them.

The injury severity of the casualties involved in the accident is assessed by the investigating police officer. Each casualty is recorded as being either slightly, seriously, or fatally injured. Further details of what is recorded are given in STATS20 (Department for Transport 2011).

### Analysis

CCIS data from phases 6, 7 and 8, which encompasses accidents collected from 2000 to 2010, were used for this analysis. The primary selection criteria for the CCIS in-depth accident cases were:

- Cars registered between 2000 and 2009 and involved in an accident occurring between 2000 and 2010
- Cars towed from the scene
- Cars fitted with front and side airbags (to represent modern vehicle fleet)
- Car occupants with known injuries

This formed the base sample of car users (drivers and passengers). Two principle automated eCall triggering options were considered:

- Condition A: Trigger in accident conditions similar to, and at least as severe as, a mandatory frontal or lateral full-scale crash test according to UN R94 or UN R95 respectively.

CCIS car occupants were differentiated, with those who experienced collisions similar to UN R94:

- The car did not roll over
- Experienced a frontal impact according to Collision Deformation Classification (CDC) SAE J224b (CDC side = 'F')
- With a Principal Direction of Force (PDF) of  $\pm 30^\circ$  (CDC PDF of 11, 12 or 01)
- With significant residual frontal crush (CDC extent  $\geq 3$ )

And those who experienced collisions similar to UN R95:

- The car did not roll over
  - Experienced a side impact according to CDC SAE J224b
  - For CDC side = 'R', PDF between  $60^\circ$  to  $120^\circ$  (CDC PDF of 02, 03 or 04)
  - For CDC side = 'L', PDF between  $240^\circ$  to  $300^\circ$  (CDC PDF of 08, 09 or 10)
  - With significant residual frontal crush (CDC extent  $\geq 3$ )
- Condition B: Trigger in conjunction with deployment of any airbag.

This sets a lower deployment threshold than the first option and may include more accident modes.

The CCIS car users were classified by those who experienced an airbag deployment and those who did not.

The resulting numbers from the CCIS analysis were scaled to match those of GB national casualty numbers. STATS19 data for accidents of the years 2010, 2011 and 2012, involving car users only, were used (Department for Transport 2013).

## RESULTS

### Results of the Analysis

There are an estimated 125,945 vehicle occupant casualties in road collisions per annum in GB, with 9,335 of these being fatally or seriously injured (KSI). Considering all injury severity levels, automatic triggering Condition A was found to capture 24,913 casualties, whereas Condition B captured 81,955 casualties. Limiting the analysis to KSI casualties, Condition A captured 3,235 casualties compared to Condition B capturing 7,565 casualties (see *Table 1*).

**Table 1. Annual GB casualty numbers and number of casualties selected by automatic triggering Conditions A and B respectively; reported for different injury severity levels and different positions**

		All severities	KSI	Fatal	Serious	Slight
Annual GB casualties	All occupants	125,945	9,335	839	8,496	116,610
	Drivers	84,989	6,247	576	5,671	78,742
	Passengers	40,956	3,088	263	2,825	37,868
Selected by Condition A	All occupants	24,913	3,235	394	2,841	21,678
	Drivers	16,641	2,243	283	1,960	14,398
	Passengers	8,271	992	111	881	7,279
Selected by Condition B	All occupants	81,955	7,565	703	6,862	74,390
	Drivers	55,246	5,017	475	4,542	50,229
	Passengers	26,709	2,548	228	2,320	24,161

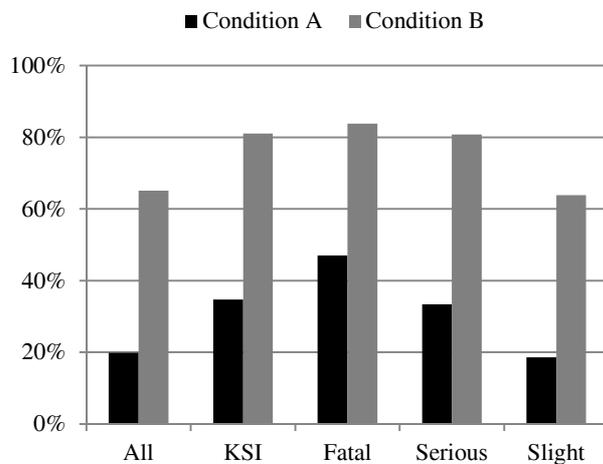
This means the sensitivity of the assessed automatic triggering conditions, i.e. the proportion of casualties successfully selected from all casualties of the corresponding severity level, compares as follows: The sensitivity in capturing casualties of any injury severity level was found to be 19.8% for Condition A and 65.1% for Condition B. When focussing on KSI casualties only, the sensitivities were 34.7% for Condition A compared to 81.0% for Condition B.

Conversely, this means if Condition A was applied, up to 6,100 KSI casualties per annum in GB (65.3%) might not be covered by automatic eCalls. For Condition B this number would reduce to 1,770 (19.0%).

The sensitivity of Condition B is elevated by the factor 3.3 for all injury severity levels and by the factor 2.3 for KSI compared to Condition A. Sensitivities split by injury severity and between drivers and passengers are given in *Table 2*; a comparison is visualised in *Figure 1*.

**Table 2. Sensitivity of automatic triggering Conditions A and B, i.e. proportion of casualties successfully selected from all casualties of the corresponding severity level; reported for different injury severity levels and different positions**

		All severities	KSI	Fatal	Serious	Slight
Condition A	All occupants	19.8%	34.7%	47.0%	33.4%	18.6%
	Drivers	19.6%	35.9%	49.1%	34.6%	18.3%
	Passengers	20.2%	32.1%	42.2%	31.2%	19.2%
Condition B	All occupants	65.1%	81.0%	83.8%	80.8%	63.8%
	Drivers	65.0%	80.3%	82.5%	80.1%	63.8%
	Passengers	65.2%	82.5%	86.7%	82.1%	63.8%



**Figure 1. Comparison of the sensitivity of automatic triggering Conditions A and B for different injury severity levels (all vehicle occupants)**

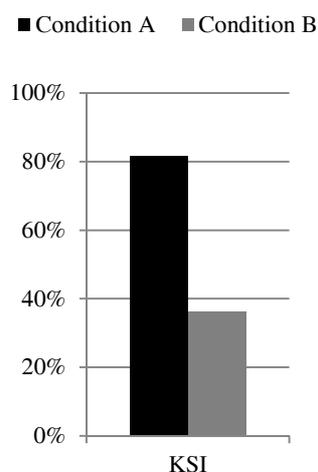
It can be seen for both conditions that the sensitivity is decreasing with decreasing injury severity level. This trend is more obvious for Condition A with a particularly marked drop in the sensitivity in selecting serious casualties compared to fatal casualties. The sensitivity of Condition B in selecting fatal and serious casualties is at a comparable level.

The sensitivity of both conditions does not vary markedly between drivers and passengers. For KSI casualties the variation is 3.8 percentage points for Condition A and 2.2 percentage points for Condition B.

The specificity of the assessed conditions, i.e. the proportion of non-KSI casualties (that is, slightly injured casualties) that were successfully not selected, compares as follows: Condition A provides a specificity 81.4% for all vehicle occupants compared to 36.2% for Condition B (see Table 3 and Figure 2). Note that the reported specificity is based on recorded injury collisions only, because no data is available for damage-only collisions.

**Table 3. Specificity of automatic triggering Conditions A and B, i.e. proportion of non-KSI casualties (that is, slightly injured casualties) not selected; reported for different positions**

		KSI
Condition A	All occupants	81.4%
	Drivers	81.7%
	Passengers	80.8%
Condition B	All occupants	36.2%
	Drivers	36.2%
	Passengers	36.2%



**Figure 2. Comparison of the specificity of automatic triggering Conditions A and B in selecting KSI casualties (all vehicle occupants)**

The specificity of Condition B is markedly lower than that of Condition A. This means if Condition A was applied, automatic eCalls would be triggered for 21,678 slight casualties per annum in GB (18.6% of all slightly injured casualties). For Condition B this number would increase to 74,390 (63.8%).

The specificity of both conditions varies only slightly between drivers and passengers.

### **Limitations of the Analysis**

The present analysis was performed based on in-depth accident data from GB. The analysis cannot be transferred in detail to the whole EU because impact typology varies across the member states. The authors have, however, no reason to believe that the general trends observed will differ or that the magnitude of the results would be of a different order. *Table 4* details the collision type distribution of the underlying GB in-depth accident data, i.e. the 3,351 CCIS cases identified by applying the primary selection criteria.

**Table 4. Collision typology of cases selected for analysis from the in-depth CCIS accident database; absolute numbers and proportion of collision types; reported for different injury severity levels**

	All severities	KSI	Fatal	Serious	Slight
Front	1,406 (42.0%)	500 (41.9%)	64 (28.1%)	436 (45.1%)	906 (42.0%)
Side	783 (23.4%)	252 (21.1%)	68 (29.8%)	184 (19.0%)	531 (24.6%)
Rear	201 (6.0%)	28 (2.3%)	5 (2.2%)	23 (2.4%)	173 (8.0%)
Multi	343 (10.2%)	133 (11.1%)	28 (12.3%)	105 (10.9%)	210 (9.7%)
Rollover	597 (17.8%)	267 (22.4%)	57 (25.0%)	210 (21.7%)	330 (15.3%)
Other	21 (0.6%)	14 (1.2%)	6 (2.6%)	8 (0.8%)	7 (0.3%)
Total	3,351 (100%)	1,194 (100%)	228 (100%)	966 (100%)	2,157 (100%)

In-depth CCIS accident data was scaled up because the STATS19 database itself does not provide enough detail to estimate whether the assessed triggering conditions would have been met. It is assumed that, accounting for deliberate case selection strategies, the CCIS data is broadly representative of national crashes. However, the CCIS data collection followed a tow-away model, which means that less damaged cars are underrepresented because these are less likely to be towed away from the scene. Compared to STATS19 the cases within each severity level will be biased towards the more severe collisions of the respective level. This might lead to an overestimate of the sensitivity of both conditions.

The analysis was limited to vehicles fitted with front and side airbags which is expected to be the case for the vast majority of passenger cars sold in Europe after mandatory introduction of eCall. However, a smaller proportion of the vehicles in the database than is to be expected in future vehicles are fitted with side-curtain airbags that are prepared to be deployed in rollover accidents. This means that some rollovers will not see airbag triggering in the database, which is why the sensitivity of Condition B might be somewhat underestimated.

Further, for the analysis of Condition A only those casualties whose car principally experienced a front- or side-impact were included. This might lead to a certain underestimate of the real-world sensitivity of Condition A, because an unknown proportion of the oblique, multi-impacts and rollover events may have involved dynamic loading conditions similar to those experienced in the UN R94 and UN R95 tests and therefore triggered an automatic eCall during the course of the real event.

Lastly, the results of this study are not intended to be absolute measures of likely automatic eCall numbers; rather they provide a comparison between the two options. Absolute numbers of expected superfluous eCalls could not be estimated because the accident data does not include damage-only collisions, for which no data was available that would allow an analysis of the specific accident conditions.

## DISCUSSION

### Sensitivity of the Assessed Triggering Conditions

A suitable triggering condition has to provide a high level of sensitivity to ensure that a high proportion of the relevant casualties benefits from the automatic eCalls. The assessment focussed on KSI casualties because the prevalence of incapacitating injuries (preventing a manual emergency call) as well as the prevalence of conditions resulting in long term disabilities (or death) without rapid medical treatment in this group is higher than among the slightly injured casualties.

The results of the accident analysis confirmed that Condition B is more sensitive than Condition A, i.e. successfully captures a higher proportion of all KSI casualties. This result confirmed expectations based on the fact that the accidents selected by A can be considered a sub-set of those selected by B: A captures crashes whose impact angle resembles UN R94 or UN R95 tests and which are of comparable or higher severity. Because vehicles always deploy the respective airbags in these tests, all of these cases are, among others, included in B.

However, the difference in sensitivity was found to be large: Condition A captures only 34.7% of KSI casualties, whereas B captures 81.0%. This would result in a difference of up to 4,330 KSI casualties per annum in GB. Even in light of the fact that the formal interpretation of Condition A applied for this analysis represents a worst case that might be somewhat unrealistic from a practical real-world implementation perspective, this difference appears high.

Condition B also exhibited an almost unvarying sensitivity in selecting fatal casualties and serious casualties respectively, whereas the sensitivity of Condition A already dropped considerably at the serious casualty level. Further, Condition B is slightly superior in equally selecting drivers as well as passengers, however the difference to Condition A is small. Considering the marked difference in sensitivity and the low level of Condition A in absolute terms, clear preference should be given to Condition B based on sensitivity.

Nevertheless, 19.0% of KSI casualties would not be captured by this condition, which is 1,770 KSI casualties per annum in GB. Although the sensitivity is expected to be higher among more recent vehicles due to the higher fitment rate of side-curtain airbags prepared for rollover protection, there will remain a proportion of collisions not captured: Airbag systems are deliberately not deployed in certain accident types (such as rear shunt accidents where the vehicle is accelerated forwards) or are not deployed because of insufficient detection capabilities (such as certain cases of under-run accidents with low deceleration levels yet high injury risk due to large intrusion).

This shortcoming of Condition B could be addressed by pursuing a non-restrictive approach when implementing the triggering condition in type-approval legislation, i.e. require triggering in the presence of the condition yet not prohibit triggering in its absence. This would ensure, via regulation, that a reasonable minimum proportion of casualties are captured, while allowing vehicle manufacturers to apply more advanced algorithms tuned to the specific vehicle characteristics and making use of the full available sensor infrastructure to cover additional KSI casualties.

### **Specificity of the Assessed Triggering Conditions**

Besides sensitivity, the triggering condition also needs to provide a high level of specificity to avoid a high number of superfluous eCalls. These two targets are of somewhat conflicting nature because the severity of injuries sustained in accidents varies not only with external accident conditions or characteristics of the vehicles involved, but also with factors which are unknown to the vehicle's triggering logic, such as the occupants' individual physiology (size and mass), injury resistance or pre-impact posture.

The specificity in selecting KSI casualties of Condition B (36.2%) was found to be markedly reduced compared to Condition A (81.4%). This means for Condition B, which is preferable based on sensitivity, approximately 74,390 of the 81,955 annually reported casualties via automatic eCalls in GB will only be slightly injured. This is also an indicator of the protection afforded by airbags where a high deceleration crash can result only in slight injuries. The overall number of automatic eCalls will be even higher and include an unknown number of additional calls from damage-only accidents (which are not quantified in this analysis). While superfluous automatic eCalls do not create dis-benefits for the road users concerned, the work of PSAPs and the correct targeting of those persons most in need of emergency medical treatment might be hampered if the number of eCalls is excessive.

It can be expected that a certain proportion of the slightly injured casualties would also call emergency services manually and there might be certain benefits from automatic eCalls, although the major part of this group will not be reliant upon the automatic triggering. The number of additional eCalls from damage-only accidents is unknown. However, there are indications that PSAPs and emergency services would be able to mitigate the negative consequences of superfluous eCalls from Condition B:

- Even among conventional emergency calls approximately 60% are reported to be non-emergencies (European Commission 2011);
- PSAPs receive ample information for triage via the MSD and the voice communication channel with the occupants. Advanced injury prediction algorithms can be applied as suggested by Bahouth *et al.* (2014) and Kusano & Gabler (2014);
- Emergency services already attend most injury collisions, even with only slightly injured occupants. Experience from the RAIDS programme also shows, that many ambulances attend collisions and treat casualties who do not appear in the STATS19 statistics (either because their injuries are relatively minor or because not every case is reported by the police); and
- The already existent implementation of Condition B in certain voluntary AECSS in the EU, Japan and USA is not known to have led to major disruptions of third party service providers (TPSPs). Furthermore, TPSPs having a system in coexistence with the mandatory eCall could help by filtering minor calls and only transferring the more severe cases.

### **Suitability for Implementation in Type-Approval Legislation**

Airbags are not mandatory equipment for any vehicle sold in the EU. Nevertheless, to pass the performance criteria of the regulatory full-scale crash tests UN R94 and UN R95 and to score sufficiently in Euro NCAP, including the pole-impact test where a head-protecting airbag is a prerequisite, virtually all passenger cars are

equipped with frontal airbags and a high and increasing proportion is also equipped with side-torso and side-curtain airbags. Hence, Condition B can be applied to virtually all passenger cars. The specific implementation of the triggering requirement could cater for the theoretically remaining vehicles that are not equipped with any airbag; for example, via implementation as an ‘if fitted’ requirement.

A feasible and low-cost means of demonstrating adherence to the triggering requirement for type-approval would be a paper-based process. The vehicle manufacturer or IVS supplier could, for example, hand in a dossier of documents that assures the type-approval authority of the non-restrictive link between airbag deployment and automatic eCall triggering.

To prevent undue restriction of design freedom, the triggering algorithm should be left to the vehicle manufacturer’s discretion within certain boundaries. This is also due to the fact that only vehicle manufacturers have advanced knowledge of the vehicle models and should therefore be enabled to tune the eCall triggering to the properties and sensors of the specific model. Implementing Condition B for mandatory triggering in a non-restrictive way does comply with these aims: Firstly, the algorithm under which conditions to trigger an airbag (and hence also trigger a mandatory eCall) is fully at the vehicle manufacturer’s discretion. The automatic eCall requirement would just ensure that emergency services are notified after collisions which the vehicle manufacturer considered severe enough to deploy non-reusable restraint systems that need to be replaced. Secondly, an implementation of the requirement that allows triggering also under different accident conditions ensures that vehicle manufacturers can apply their expertise to also cover the remaining proportion of casualties in non-airbag deployment collisions.

## Conclusions

This study found that mandatory triggering of automatic eCalls under accident conditions similar to, and at least as severe as, the frontal and lateral full-scale crash tests defined in UN R94 and UN R95 respectively cannot successfully ensure via regulation that a high proportion of casualties will benefit from automatic eCalls. In contrast, a non-restrictive requirement to trigger automatic eCalls after collisions where an airbag deployed was found to cover up to 4,330 fatally or seriously injured casualties more per annum in GB (57,042 casualties when considering all injury severity levels) and is, therefore, considered a more suitable candidate for implementation in type-approval legislation.

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