Identification of accident scenarios with a special relevance for injuries and psychological impairments that result in long-term consequences

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I. INTRODUCTION

Road traffic incidents bring about reduced productivity, necessitate medical treatment, and frequently lead to dependence on help to undertake daily tasks [1]. Battling serious injuries with long-term consequences (LTCs) arising from road traffic accidents remains an important issue for Vision Zero. Accordingly, the objectives in this project are to improve the collection of medical data on physical and cognitive health consequences, and to develop countermeasures and assessment methods for the protection of all road users based on accident and injury statistics, including LTCs. This paper presents the critical accident scenarios resulting in LTCs for car occupants and cyclists. Based on that, the selected road accidents are presented, and will be further investigated in the project. The work described was carried out as part of the EU project ProtAct-Us (Grant No. 101147445).

II. METHODS

To define use cases for the simulation of accidents that commonly lead to LTCs, an analysis of the in-depth accident data from the MHH Accident Research Unit and of data collected during the EU-funded project REHABIL-AID was conducted on the level of the accident participants (Fig. 1).

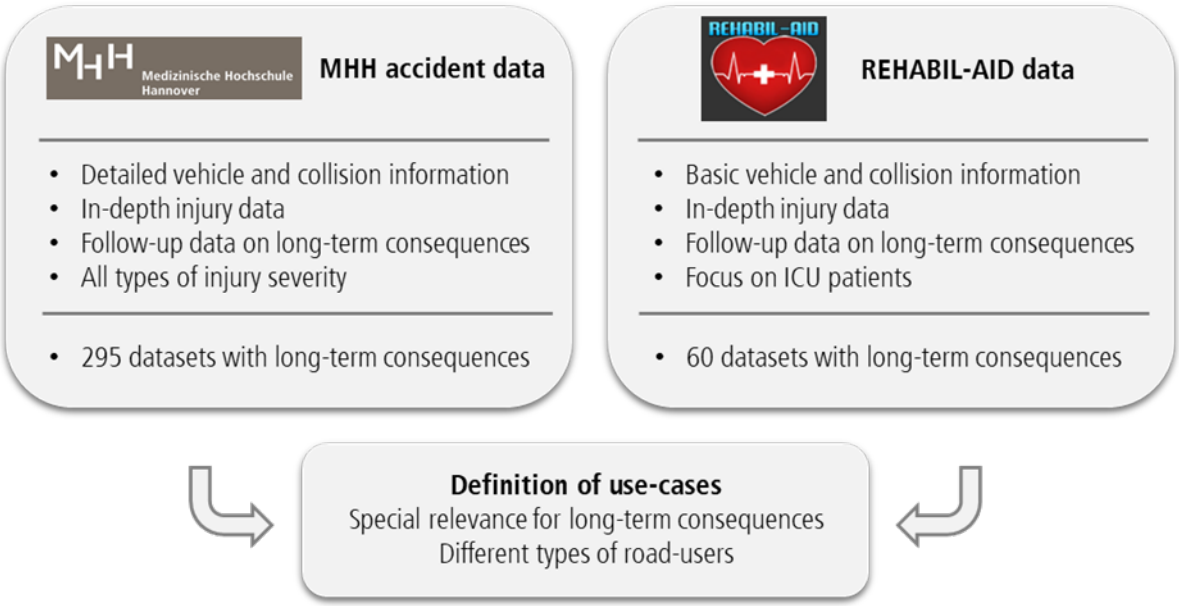

Fig.1: Databases with information on LTCs, used for definition of use-cases.

Both databases, MHH [2] and REHABIL-AID [3], include general accident data collected at the time of the accident occurrence and data on LTCs from a follow-up data collection, for both databases approximately one year after the accident, including information on the fields of pain, restricted mobility, physical, psychological or social problems. While both databases include patients sustaining all severity levels, REHABIL-AID focused on patients admitted to an intensive care unit and MHH focuses on all types of accident participant.

In the next step, the detailed injury information of this group was coded into detailed injury categories based on a list established in the scope of the EU project EUROCOST. Subsequently, the two datasets were examined for the road user groups ‘car occupants’ (including 130 cases from MHH and 16 cases from REHABIL-AID) and

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'cyclists' (including 103 cases from MHH and nine cases from REHABIL-AID), and baseline use-cases were identified.

III. INITIAL FINDINGS

Analysing MHH data for car occupants with LTCs, the most frequently injured body regions are the thorax (48%), head (35%), neck (27%), and lower extremities (27%). The most severe collisions that led to LTCs were primarily frontal (57.4%) or rear-end (23.3%) impacts. Notably, while men accounted for 58.8% of all accidents, women were more likely to report LTCs (58.5%). The most common reported collision partners were cars (50.8%) and objects (19.2%). The REHABIL-AID dataset shows that the most injured body regions are the lower extremities (40%), thorax (21%) and upper extremities (16%), while the most relevant collisions are frontal (56%) and fronto-lateral (25%) impacts. In those collisions, 75% of the injured with LTCs were male, and 25% were female. It also showed that the most common collision partners were a car (63%) or an object (25%). From these crash scenarios the baseline use-cases were identified as:

- **Frontal impact scenarios,** including driving accidents with the direction of force having a high frontal component for accidents occurring at intersections or while turning.
- **Rear-end collision scenarios**, such as those occurring at the end of a traffic jam.

For cyclists with LTCs, the most affected body regions were the lower extremities (56.3%), followed by the upper extremities (48.5%), the head (40%), and the thorax (36%). The most severe collisions were typically characterised by frontal or lateral forces impacting the cyclist, mostly from a car or during a single-vehicle accident, e.g. colliding with a curb, with slightly more women (53.4%) than men (46.6%) being affected. The REHABIL-AID dataset shows the most frequently injured body regions are the lower extremities (35%), head (16%) and face (12%), as well as upper extremities (12%). Lateral (45%) and fronto-lateral (22%) collisions as well as single accidents (22%) were the most relevant accident scenarios. It also shows that a car (45%), a truck or bus (33%), but also an object (11%) were the most common collision partners. The most common cases identified as baseline use-cases for simulations are:

- **Single-accident cases,** where a cyclist loses balance due to an obstacle, such as a curb or pothole, on a straight road.
- **Vehicle-related collisions**, where a cyclist with the right-of-way is impacted by a non-priority vehicle at an intersection.

IV. DISCUSSION

The analysis of the accident data, with a focus on LTCs, revealed that there are specific accidents and injured body regions that result in a higher chance of suffering from LTCs. These are not always dependent on the injury severity but include, for example, participants who were uninjured during the accident but suffer from psychological sequela [4].

To identify these specific circumstances, a field study on LTCs resulting from accidents is set up in three different countries with the focus on: Quality of life; and Influencing factors, e.g. health, social support, mental health, anxiety, depression, post-traumatic stress disorder, cognition deficits, socio-economic costs.

Next, the goal is to establish a metric to describe the severity of expected LTCs for different injuries and to predict the individual risk in order to optimise the prevention measures and the therapy of patients with expected long-term physical and psychological consequences.

The identified scenarios for car occupants and cyclists, as well as the relevant body regions for LTCs, will be further analysed through virtual testing using HBMs. The aim is to develop engineering tools and methods to assess injuries with LTCs and to develop future countermeasures to reduce the injury risk in the relevant body regions and therefore minimise the risk for LTCs.

V. REFERENCES

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