Original Article

Medico-Legal Aspects of Road Traffic Accidents in the Intensive Care Unit of Heinrich Lübke Hospital, Diourbel (Senegal)

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Abstract

Introduction: Road traffic accidents (RTAs) are a major global public health concern, particularly in low- and middle-income countries. Their human, economic, and medico-legal consequences remain considerable. This study aimed to analyze the medico-legal aspects of deaths resulting from RTAs in the Intensive Care Unit (ICU) of Heinrich Lübke Hospital in Diourbel, Senegal.

Objective: To assess the epidemiological, injury-related, and medico-legal characteristics of RTA-related deaths in a regional ICU.

Methods: We conducted a retrospective, descriptive, and analytical study of 52 deaths resulting from RTAs recorded in the ICU of Heinrich Lübke Hospital, Diourbel, between January 2020 and December 2024. Data were collected from medical records and analyzed according to sociodemographic variables, accident circumstances, types of injuries, and medico-legal management.

Results: Most victims were male (82.7%, n=43), with a sex ratio of 4.8. The median age was 36.2 years (range: 6–72), and 34.6% were under 20 years old. The majority resided in urban areas (73%) and had an occupation (62%). Collisions between vehicles were the leading mechanism (42.3%), with motorcycles involved in 48.1% of cases. Passengers accounted for 51.9% of victims, followed by pedestrians (30.8%). Polytrauma was predominant (57.7%), with cranioencephalic injuries in 82.7% of cases. Death occurred most often within the first week of hospitalization (34.6%). Only 21.2% of victims underwent external examination or autopsy.

Conclusion: Road traffic accidents remain a leading cause of mortality among young adults in Senegal, dominated by fatal head injuries. The limited number of medico-legal autopsies restricts the understanding of the real causes of death. Strengthening road safety prevention, improving pre-hospital care, and systematically enforcing medico-legal procedures are essential to reduce mortality and improve forensic rigor in Senegal.

Keywords: Road traffic accidents – Forensic medicine – Intensive care – Head trauma – Autopsy – Senegal

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Introduction

Road traffic accidents (RTAs) represent one of the leading causes of morbidity and mortality worldwide. According to the World Health Organization (WHO), they account for approximately 1.3 million deaths annually and nearly 50 million injuries, with an estimated economic cost of 3% of the Gross Domestic Product (GDP) for most countries[1]. Almost 90% of RTA-related deaths occur in low- and middle-income countries (LMICs), where road infrastructure, traffic regulations, and emergency care systems remain inadequate[2].

Young people aged 5 to 29 years are the most affected group, making road traffic injuries the first cause of death within this age range. "Vulnerable road users" — pedestrians, cyclists, and motorcyclists — account for more than half of all fatalities[1]. In Africa, the road traffic mortality rate is estimated at 27.2 deaths per 100,000 inhabitants, the highest in the world[3].

In Senegal, the situation is equally alarming. In 2014, 12,547 accidents were officially recorded, resulting in 22,441 victims, including 433 deaths[4]. These figures are likely underestimated due to weak reporting systems and the absence of a comprehensive national injury registry. Peripheral regions such as Diourbel are particularly affected, owing to deteriorated road networks, the increasing number of motorcycles, and frequent non-compliance with traffic regulations.

From a forensic perspective, RTAs present major challenges regarding the identification of the exact causes of death, the documentation of clinical findings, and the implementation of judicial procedures. In most regional hospitals, post-mortem examinations or medico-legal autopsies are rarely performed, limiting both the probative value of death certificates and the epidemiological understanding of fatal injuries.

Hospital intensive care units play a strategic role in the observation of severe RTA cases — polytrauma, head injuries, and delayed deaths — providing crucial data for understanding the injury mechanisms, victim profiles, and the adequacy of medico-legal management.

Although road traffic accidents are well documented globally, there is a clear lack of studies focusing specifically on fatalities occurring in intensive care units in Senegal. Most national studies address immediate deaths at the scene or cases handled in emergency departments, but the characteristics of victims who reach the ICU and subsequently die remain largely undocumented. This represents an important research gap, especially in regions like Diourbel, where road safety challenges and limited medico-legal resources coexist.

Furthermore, the scarcity of medico-legal autopsies in Senegal strongly limits the forensic accuracy of death certification. The absence of systematic forensic procedures reduces our understanding of fatal injury mechanisms and weakens the legal value of medical documentation. Therefore, this study responds to a crucial need to document the epidemiological patterns, injury characteristics, and medico-legal management of RTA-related deaths in a regional ICU.

Materials and Methods

Study Setting

The study was conducted in the Intensive Care Unit (ICU) of Heinrich Lübke Hospital in Diourbel, a level-2 public healthcare facility located in central Senegal. The hospital, rehabilitated in 2004 through Sino-German cooperation, has a total capacity of 188 beds, including 6 ICU beds equipped for managing life-threatening conditions. The unit is overseen by an anesthesiologist-intensivist and staffed by a team of state-registered nurses and nursing assistants.

Diourbel is situated approximately 145 km from Dakar, at the crossroads of several major intercity roads with high traffic density. The district serves a population estimated at around 378,000 inhabitants, 45% of whom live in urban areas and 55% in rural zones. The main economic activities—trade and agriculture—generate high mobility and thus significant exposure to road traffic risks.

Study Design and Period

This was a retrospective, descriptive, and analytical study conducted over a five-year period, from January 1, 2020, to December 31, 2024.

Study Population

The study population included all patients who died in the ICU of Heinrich Lübke Hospital following a road traffic accident (RTA) during the study period.

Inclusion Criteria

- Victims of RTAs admitted to the ICU of Heinrich Lübke Hospital;
- Death occurring during ICU hospitalization;
- Availability of a complete and usable medical file, including clinical, paraclinical, and medico-legal data.

Exclusion Criteria

- Incomplete or illegible medical records lacking essential information for statistical analysis;
- Deaths not related to traumatic causes or unrelated to road traffic accidents.

Out of 68 identified deaths related to RTAs, 52 had complete and usable medical files, yielding a data exploitation rate of 76.5%. Files were excluded when essential clinical or medico-legal variables were missing. This approach follows standard methodological principles for retrospective studies, which recommend excluding incomplete records to minimize information bias.

Study Variables

The following variables were analyzed:

- **Sociodemographic data:** age, sex, occupation, area of residence, level of education;
- **Circumstances of the accident:** location, time of occurrence, mechanism, type of vehicle, type of road user;
- **Clinical and injury characteristics:** type of trauma, location of injuries, imaging and laboratory findings, presence of nosocomial infections;
- **Medico-legal parameters:** time to death after admission, type of post-mortem medico-legal procedure (simple certification, external examination, autopsy).

Data Collection and Analysis

Data were extracted from ICU registers, individual medical records, and death certificates. All information was entered and analyzed using Microsoft Excel® 2021.

A descriptive analysis was performed. Quantitative variables were expressed as means, medians, and ranges, while qualitative variables were presented as frequencies and percentages.

Ethical Considerations

This study was conducted in strict compliance with ethical principles, particularly the confidentiality and anonymity of all victims. Prior authorization was obtained from the Management of Heinrich Lübke Hospital before data collection.

Results

1. Sociodemographic Characteristics

A total of 52 victims of road traffic accidents (RTAs) who died in the Intensive Care Unit (ICU) of Heinrich Lübke Hospital, Diourbel, were included in the study.

Sex and Age

A clear male predominance was observed, with 43 men (82.7%) and 9 women (17.3%), yielding a sex ratio of 4.8. The mean age of victims was 36.2 ± 15.8 years (range: 6–72 years). Individuals under 20 years old accounted for 34.6% of cases, followed by those aged 21–30 years (25%) and 31–40 years (17.3%).

Place of Residence and Occupation

Most victims lived in urban areas (n=38; 73%). Regarding occupation, 32 victims (62%) had identifiable employment. Traders were the most represented (n=12; 23.1%), followed by students (n=7; 13.5%) and motorcycle drivers ("djakartamen") (n=5; 9.6%).

2. Circumstances of the Accidents

Location and Time of Occurrence

Most crashes occurred on intercity roads (n=30; 58%), compared to urban roads (42%). Accidents occurred more frequently at night (n=23; 44.2%), with a peak around 9 p.m.

Mechanisms and Types of Road Users

The most frequent mechanism was collision between vehicles (n=22; 42.3%), followed by vehicle–pedestrian impacts (37.2%) and rollovers (7%). Motorcycles were involved in 48.1% of cases (n=25).

By road user category, passengers were the majority (n=27; 51.9%), followed by pedestrians (n=16; 30.8%) and drivers (n=9; 17.3%).

3. Hospital Admission and Initial Condition

All victims were transported by the National Fire Brigade to Heinrich Lübke Hospital. The Emergency Department (ED) served as the primary entry point before ICU transfer. A loss of consciousness was reported in 33 victims (63%).

At admission, 25 patients (48%) were unconscious, and 14 (27%) presented with psychomotor agitation. The Glasgow Coma Scale (GCS) score ranged between 8 and 9 in 48.1% of cases. The delay between ED admission and ICU transfer was less than 24 hours in 61.5% of cases.

4. Clinical, Paraclinical, and Injury Findings

Types of Trauma

Polytrauma was predominant (n=30; 57.7%), followed by isolated craniofacial or cranial trauma (n=16; 30.8%). Thoracic and spinal injuries were less common (3.8% and 1.9%, respectively).

Sites of Fatal Injuries

Cranioencephalic lesions were the most frequent (n=43; 82.7%), followed by thoracic and shoulder-girdle injuries (42.3%). Maxillofacial injuries were reported in 13.5% of cases, whereas pelvic or abdominal injuries were rare (1.9%).

Imaging and Laboratory Findings

Imaging investigations revealed central nervous system damage (cerebral hematomas, meningeal hemorrhages, or spinal cord lesions) in 78.8% of cases. Multiple bone fractures were reported in half of the medical records (50%). Laboratory findings showed anemia in 32.7% of cases, and nosocomial infections in 8 victims (15%), most frequently involving *Staphylococcus aureus*.

5. Outcome and Medico-Legal Aspects

Time to Death

Most deaths occurred within the first week of hospitalization (n=18; 34.6%). Seven victims (13.5%) died within the first 24 hours, and four (7.7%) died within one hour of admission.

Medico-Legal Management

Post-mortem medico-legal procedures varied considerably. Only 11 victims (21.2%) underwent an external examination or autopsy. In 78.8% of cases, only a simple medical death certificate was issued, without a medico-legal hold.

Autopsies were mainly performed in polytrauma cases (54.5%) and severe head injuries (45.5%).

6. Analytical Findings:

The inferential analyses showed:

- Association between road user type and fatal injury location:

Pedestrians and motorcyclists showed significantly higher rates of cranioencephalic injuries (χ^2 test, $p < 0.05$).

- Association between accident mechanism and polytrauma:

Vehicle-to-vehicle collisions were significantly associated with a higher proportion of polytrauma cases compared to pedestrian impacts ($p < 0.05$).

- Association between time-to-death and initial Glasgow score:

Victims with GCS ≤ 8 tended to die earlier (<48h), although the association did not reach statistical significance ($p = 0.07$).

Discussion

This study presents several limitations:

- Its retrospective nature exposes it to documentation bias.
- 23.5% of files were excluded due to missing key data.
- Lack of standardized recording of pre-hospital delays and initial vital signs.
- Very low autopsy rate (21.2%), reducing medico-legal accuracy.
- Small sample size limiting generalizability.

This five-year retrospective study, conducted in the Intensive Care Unit (ICU) of Heinrich Lübke Hospital in Diourbel, highlights the high lethality associated with road traffic accidents (RTAs) and underscores the predominance of cranial injuries in

post-traumatic mortality. It also confirms the male predominance, the vulnerability of young adults, and the limited medico-legal coverage in Senegal

1. Epidemiological Profile of Victims

The strong male predominance (82.7%) aligns with global and regional findings showing that men are disproportionately affected by road trauma. Similar proportions have been reported in Iran (79%), Jordan (81%), Turkey (77%), Lebanon (77%), Egypt (80%), and the United Arab Emirates (89%)[5–8]. This gender disparity is largely attributed to greater male exposure to traffic—particularly in professional driving and motorcycle use—as well as to risk-taking behaviors such as speeding, alcohol consumption, and failure to wear helmets.

The mean age of 36.2 years reflects the predominance of young, economically active adults, who represent the most vulnerable group in road traffic trauma. Comparable mean ages have been reported in Morocco, Senegal, and Cameroon, ranging between 32 and 40 years[9–11]. This observation carries significant socioeconomic implications, as fatalities often occur among the country's most productive population segment.

The predominance of victims from urban areas (73%) likely results from high traffic density and the widespread use of motorcycles in regional centers such as Diourbel, where helmet use and road discipline remain limited.

2. Circumstances and Mechanisms of Accidents

Intercity roads accounted for the majority of crashes (58%), consistent with findings by Mansouri et al. in Morocco (53%) and Ndiaye et al. in Dakar (60%) [9,10]. Poor road maintenance, inadequate lighting, and lack of signage on secondary roads increase the risk of head-on collisions and loss of vehicle control.

The most frequent mechanism was vehicle-to-vehicle collision (42.3%), corroborating findings from other African studies[9–12]. Motorcycles were involved in nearly half of all crashes (48.1%), reflecting the rapid expansion of motorcycle transportation across West Africa. These two-wheeled vehicles, with minimal structural protection, expose users—especially young males—to a significantly higher risk of fatal injury. Studies from Burkina Faso and Benin reported that over 80% of motorcyclists did not wear helmets at the time of the crash[13,14].

Most accidents occurred at night (44.2%), which can be explained by driver fatigue, reduced visibility, excessive speed, and, in some cases, alcohol consumption. Similar temporal trends have been observed in France and Morocco, where the majority of fatal accidents occur between 6 p.m. and midnight[15,9].

3. Types of Trauma and Fatal Lesions

Polytrauma dominated our series (57.7%), followed by isolated cranioencephalic trauma (30.8%). These results are consistent with those of Mansouri et al. (Morocco: 46.8% polytrauma) and Ndiaye et al. (Senegal: 52% severe head trauma)[9,10].

Cranial injuries, present in 82.7% of cases, played a decisive role in mortality. The head is particularly vulnerable in motorcycle crashes, especially in the absence of protective helmets. According to the WHO, correct helmet use reduces the risk of death by 40% and head injury by 70%[1].

Thoracic (42.3%) and maxillofacial injuries (13.5%) were frequent, reflecting the high kinetic energy involved in most collisions. Multiple fractures and pulmonary contusions identified through imaging support the notion of high-impact mechanisms.

The predominance of intracranial hemorrhages and polytrauma as causes of death has been consistently reported in several African studies[10,11,13], emphasizing the importance of early, multidisciplinary resuscitation.

4. Time and Circumstances of Death

The median time to death (approximately 40 hours) indicates that most victims succumbed within the first few days of hospitalization, before stabilization could be achieved. This finding is consistent with Mansouri et al. (median: 72 hours) and Pérez et al. in Spain (92% of deaths within 30 days)[9,16].

The prognosis is influenced by several factors: the severity of initial injuries, the delay in evacuation, the availability of ICU resources, and the quality of neurological monitoring. In our setting, delayed transport, absence of medicalized pre-hospital

care, and limited technical capacity remain major aggravating factors.

5. Medico-Legal Aspects

One of the most striking findings is the limited implementation of medico-legal procedures: only 21.2% of deaths were subjected to external examination or autopsy. This proportion is far below international standards, revealing a persistent lack of medico-legal culture in Senegalese hospitals.

According to Senegal's Code of Criminal Procedure and WHO recommendations, all suspicious, accidental, or traumatic deaths must be subject to a medico-legal hold ("obstacle médico-légal"), prohibiting burial before forensic examination by the prosecutor or a qualified pathologist[17].

The low autopsy rate (21%) confirms the medico-legal deficit previously highlighted by Amundsonet al.[18] and Mbassi Awa et al.[19]. Several barriers contribute to this situation: shortage of forensic physicians, reluctance of families, and insufficient awareness of the judicial importance of autopsy.

Our results emphasize the urgent need to strengthen road safety prevention, improve medico-legal training, and systematically enforce medico-legal procedures for all trauma-related deaths[20–24].

6. Implications and Perspectives

The findings of this study call for several key actions:

- Reinforce road safety measures, including stricter enforcement of helmet and seatbelt laws;
- Train motorcycle drivers and regulate informal urban transport;
- Improve pre-hospital emergency care by equipping fire and rescue services with advanced medical transport systems;
- Develop regional medico-legal services, ensuring the systematic implementation of medico-legal holds for all accidental deaths.

Conclusion

Road traffic accidents remain a critical cause of mortality in Senegal, particularly among young adults. This study highlights the predominance of severe head injuries and the systemic constraints affecting medico-legal documentation. Strengthening road safety measures, improving pre-hospital care, and ensuring systematic medico-legal procedures for traumatic deaths are essential.

This study highlights several systemic shortcomings: insufficient medicalization of pre-hospital transport, delayed evacuation, limited intensive care equipment, and the near absence of medico-legal autopsies. These deficiencies not only compromise the quality of clinical management but also undermine the forensic reliability of death certification and legal documentation.

There is an urgent need to strengthen road safety measures—through public awareness campaigns, strict enforcement of helmet and seatbelt use, and speed regulation—while also improving trauma and intensive care capacity at the regional level. Furthermore, it is essential to mandate medico-legal procedures ("legal holds") for all traumatic deaths and to develop a national road trauma registry to facilitate epidemiological monitoring and forensic accountability.

Finally, training hospital physicians in medico-legal documentation and death certification will enhance forensic accuracy, justice delivery, and public health surveillance, ultimately contributing to a sustainable reduction in RTA-related mortality in Senegal.

Future studies should be multicentric, prospective, and incorporate systematic autopsies where possible. Developing a national trauma registry would significantly improve surveillance and forensic reliability.

Conflict of Interest and Funding Disclosure

Conflict of Interest: The author…, certifies that this manuscript is an original work and has not been submitted to or published in any other scientific journal. The study was conducted independently, without any external sponsorship or institutional support. The manuscript is submitted to the *Indian Journal of Forensic Medicine & Toxicology* in full compliance with the journal's authorship and publication policies.

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