Risk factors and mortality associated with undertriage after major trauma in a physician- led prehospital system: a retrospective multicentre cohort study

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Research Article

Keywords: trauma, triage, prehospital care, EMS, mortality

Posted Date: March 22nd, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1412016/v1

Abstract

Background

Direct transport of patients suffering major trauma to level-I trauma centres may reduce mortality. Emergency medical services therefore aim to limit undertriage so that all severely injured patients receive proper vital trauma care. Nevertheless, undertriage have been poorly examined in a physician-led prehospital system. The main objective of this study was to assess the incidence of undertriage. We also sought to determine its potential risk factors, as well as to assess its association with mortality.

Methods

A multicentre retrospective cohort study was performed using 2011–2017 data from a French regional trauma registry (RESUVal) that includes prehospital, and in-hospital data on trauma patients. All adults assessed by a physician-led mobile medical team with major trauma (Injury Severity Score [ISS] ≥ 16) were included. Major trauma patients transported directly to a level-I trauma centre were considered as correctly triaged. Multivariate logistic regression was used to identify factors associated with undertriage.

Results

7,110 trauma patients were screened, of whom 2,591 had an ISS ≥ 16. Median age was 42 (IQR 27–59) years old, 75.0% were male and 12.4% (n = 320) were undertriaged. In-hospital mortality was 18.3% among undertriaged patients *vs* 16.2% among correct-triaged patients ($p = 0.473$). Patients aged 51–65 years had higher risk for undertriage (OR = 1.60, 95%CI [1.11;2.26], $p = 0.01$). Conversely, mechanism (fall from height 0.62 [0.45;0.86], $p = 0.01$; gunshot/stab wounds 0.45 [0.22;0.90], $p = 0.02$), longer on-scene time (> 60 minutes, 0.62 [0.40;0.95], $p = 0.03$), prehospital endotracheal intubation (0.53 [0.39;0.71], $p < 0.001$), and prehospital focused assessment with sonography FAST (0.15 [0.08;0.29], $p < 0.001$) were associated with a lower risk for undertriage. After adjusting on severity, undertriage was not significantly associated with a greater risk of mortality (1.22 [0.80;1.89], $p = 0.36$).

Conclusions

In our region-wide, physician-led prehospital EMS system, undertriage in major trauma was higher than recommended and advanced age was associated with higher risk for undertriage. Conversely, a pre-hospital FAST was associated with a lower risk for undertriage. Specific triage procedures should be discussed in older trauma patients and further studies are needed to evaluate the impact of prehospital FAST on triage performance. We noted that undertriaged patients had no higher risk for mortality suggesting no impact of secondarily transfer and/or high trauma care quality in level-II trauma centres. Undertriage definition should be tailored to fit local trauma systems organization.

Background

Major trauma is a worldwide multifactorial health issue. Prehospital triage is a highly important component of trauma care. Indeed, the accurate prehospital triage and direct transportation to trauma centres with high level of trauma care designation is consensually considered optimal as it may be associated with a lower risk of mortality [1–3], whereas secondary transfer to a trauma centre may increase mortality[4]. Therefore, Emergency Medical Services (EMS) caregivers aim to avoid undertriage, defined by the American College of Surgeons Committee on Trauma (ACSCOT) as the transportation of severely injured patients to a trauma centre with a lower level of trauma care designation or another acute care facility. The ACSCOT guidelines for field triage recommends a maximum undertriage proportion of 5% and a 35% proportion of overtriage in order to limit the potentially life-threatening impacts of undertriage, to optimize specialized trauma resource use and to minimize healthcare expenditure [5]. Nevertheless, overtriage may prevent longer prehospital transfer times, and interregional paramedic transportation. A recent systematic review reported undertriage proportions ranging between 1 and 71.9%, and this wide range was due to the heterogeneous definition across studies [6].

In France, prehospital EMS is physician-led, from call reception to on-scene intervention, where care is provided by a mobile medical team (MMT). This model of EMS was shown to be an effective way to optimize prehospital triage [7, 8] and this could partly be due to the use of a Vittel criteria-based grading system [7, 9]. However, the factors associated with undertriage and their impact on patient-centered outcomes have yet to be investigated in this physician-led prehospital system.

The main objective of this study was to assess the incidence of undertriage. We also sought to determine its potential risk factors, as well as to assess its association with mortality.

Methods

Study design and setting

We conducted a retrospective multicentre cohort study using the *Réseau des Urgences de la Vallée du Rhône* (RESUVal) Trauma Registry. This area has a population of 3 million inhabitants (Fig. 1) and includes two level-I, two level-II, and 12 level-III trauma centres. RESUVal prospectively collects prehospital and in-hospital information on all trauma patients managed by a MMT.

The prehospital EMS in France is a 24-hour-physician-led system, and out-of-hospital trauma or medical life-threatening situations are managed by the *Service d'Aide Médicale d'Urgence* (SAMU).[10] Country-wide 24/7 access to the SAMU is provided by a single national telephone number [15]; a few calls are also received through the universal European number for emergency assistance [112]. A dispatching physician assesses the situation over the phone and can activate a MMT in critical cases. The MMT is composed of an emergency physician or an anesthesiologist-intensivist, a nurse, an ambulance driver, and a medical resident (in academic centres). MMT can either be transported in a ground or a helicopter ambulance and are distributed throughout the country at hospital-based locations named *Service Mobile d'Urgence et de Réanimation* (SMUR). In suspected life-threatening injuries, firefighter crews, as well as an MMT, are systematically dispatched to the scene. If needed, MMT physicians are trained to perform the following procedures in the prehospital setting: general anesthesia, endotracheal intubation and mechanical ventilation, intravenous fluid resuscitation, packed red cells transfusion, catecholamines infusion, intraosseous catheter, needle, and finger thoracostomy, pelvic binder placement, and external hemorrhage control procedures. After clinical evaluation, the on-scene physician and the dispatching physician determine together the most adapted care facility for the patient(s). Clinical judgment combined with a regional triage protocol based on Vittel criteria are used to make triage decision (see online Table S1).

Study Population

All trauma patients aged 18 years and over, managed by a prehospital MMT from January 2011 to December 2017 with an ISS ≥ 16 [11] were included in our analyses. Patients who died in the prehospital setting (either on-scene or during transportation) were not included as this could have influenced the MMT destination.

Data Collection

Prehospital, Emergency Department (ED) and Intensive Care Unit (ICU) data is collected by the physician in charge of the patient. Research technicians provide continuous monitoring of the completeness and correctness of the RESUVal. They also collect patient outcomes at hospital discharge. Data management was performed by a data-manager-statistician (CC) and a PhD methodologist (LF), both are full-time employees of the RESUVAL. MMT physicians were asked to fill out a standardized case report form for any trauma patient with at least one of the Vittel criteria corresponding to effective or supposed seriously injured patients. A research assistant reviewed patients' medical records if the case report form was incomplete.

Study Data

The following prehospital variables were prospectively recorded: age, sex, type and cause of trauma, first physiological parameters measured by the MMT (systolic blood pressure, heart rate, peripheral oxygen saturation (SpO2), respiratory rate, shock index, Glasgow coma scale (GCS) and capillary haemoglobin concentration (HemoCue® Hb 201 + system)). Data regarding prehospital procedures and management was also recorded: endotracheal intubation, thoracostomy, chest tube insertion, pelvic binder placement, Focused Assessment with Sonography for Trauma (FAST). The following scores were calculated after anatomical and physiological assessments were completed: Abbreviated Injury Scale (AIS) score based on the 1998 version, ISS, as well as the mechanism, GCS score and Age, arterial Pressure score (MGAP) score. In-hospital mortality was also reported.

Outcome measure

The primary outcome of this study, undertriage, was defined as a severe trauma patient (ISS ≥ 16) who was not directly admitted to one of the two regional level-I trauma centres.

Our secondary outcome, in-hospital mortality, was defined as a trauma patient who died in the hospital (all causes). The causes of death were determined by the physicians in charge.

Statistics

Univariate analysis

Baseline characteristics were described by frequencies and percentages for categorical variables, medians, and interquartile range [IQR] for continuous variables. Groups were compared using the Pearson chi-squared test for categorical variables and the non-parametric Wilcoxon rank-sum test for continuous variables.

Multiple Imputation

Candidate covariates were identified based on a literature review and univariate analysis; age, sex, season, year of admission, type of transport, time on site, transportation time, GCS, trauma mechanism, type of accident (weapon, road, fall, other), shock index, endotracheal intubation, FAST. In our cohort, the candidate covariates were complete for 61% (n = 1,583). To gain statistical power and reduce bias, we performed multiple imputation by generating a total of 100 datasets over 20 iterations. Regressions were calculated separately on each dataset, and then combined into a single result using Rubin's rule [12]. Auxiliary variables were added to optimize the imputation process [13]: centre level, cause of injury (gunshot/stab wounds, suicide, accident), head trauma, abdominal trauma, thoracic trauma, limb trauma, pelvis trauma, spinal trauma, prehospital administration of catecholamines, prehospital endotracheal intubation, admission to the ICU and AIS by body zone. We used the mice package in R software, and observed convergence for all covariates [14].

Sensitivity Analysis

We performed two logistic regressions with undertriage as the outcome; 1) based on complete cases (CC), and 2) post-multiple imputation, and calculated the variation rate (%) obtained as (100*(Odds Ratio $[OR]_{MI}-OR_{CC})/OR_{CC}$)). We observed the presence of a selection bias because the patients dropped from the CC approach were not distributed completely at random; the effects of age (especially 51–65 and > 81 years old), the season, the gunshot circumstances and the on-scene time were characterized by the largest variation rate (see online Table S2). This approach validated the relevance of the multiple imputation approach. We evaluated the sensitivity of the multiple imputation to the missing at random (MAR) hypothesis by using the method proposed by Héraud-Bousquet *et al.* [15]. This method up weight imputations which are more plausible under missing not at random. A variation rate is then computed under different deviations from the MAR hypothesis. We showed that most of the covariates were robust to a deviation to the MAR hypothesis with variation rates under 5%. Only 2 variables were slightly sensitive to a deviation to the MAR hypothesis, the on-scene time and the FAST (see online Fig S1). For these 2 covariates, the variation rate was ranged between 5% and 15%. Given the estimated OR, variation rate of 15% would not change the effect direction or significance.

Multivariate Logistic Regressions

We performed two multivariate logistic regressions. The first one to estimate undertriage determinants as the primary outcome based on 2,591 patients. The results were evaluated on each imputed dataset and pooled using the Rubin's rule. The second logistic regression, to estimate the effect of undertriage on mortality as secondary outcome, considering in-hospital mortality, was based on the 1,724 patients admitted or deceased before admission to an ICU, to estimate the effect of undertriage on mortality as secondary outcome, considering in-hospital mortality. This logistic regression was performed on the 91% of the patients (1,570/1,724) without missing data (covariates and outcome). The results are presented as odds ratios (ORs) with 95% confidence intervals (CIs) and p-values. P-values equal or lower than 0.05 were considered significant.

Results

Characteristics of the included population

During the study period, a total of 7,110 trauma patients were screened, of which 2,591 had an ISS ≥ 16 and were included in our analyses. Overall, 75% (n = 1,934) were men and the median age [IQR] was 42 years [27–59]. Most included patients had sustained a blunt trauma (94.1%, n = 2,406) and road collision was the main trauma mechanism (57.4%, n = 1,472) followed by fall (21.2%, n = 542).

A total of 12.4% (n = 320) patients were considered undertriaged (Fig. 2), most of whom were admitted in a level-II trauma centre (63.2%, n = 202). The median ISS was lower in the undertriage group (22 [17–29] vs 25 [19–34], $p < 0.0001$).

Road collisions were more frequent in the undertriage group (66.6% vs 56.1%, p = 0.0006). The total duration of prehospital care (from dispatching to hospital admission) was statistically shorter in the undertriage group (57.5 *vs* 60 minutes, p = 0.013) and a lower proportion of these patients were transported by helicopter (12.1% *vs* 22.4%, p = 0.0002, Table 1).

The most frequent prehospital intervention was endotracheal intubation (40.3%); this was less frequently performed in the undertriage group (26.2% *vs* 42.3%, $p < 0.0001$; Table 1).

In-hospital mortality occurred for 16.5% (n = 351) of patients, and there was no significant difference between under- and correct-triage groups (18.3% vs 16.2%, p = 0.4730; Table 2). Among undertriaged patients, 15.6% (n = 50) were secondarily transferred to a level-I centre.

Table 1
Patient characteristics

Characteristics	Total population (n = 2,591)	Undertriage (n = 320)	Correct triage (n = 2,271)	p-value
Demographics				
Sex, male, n = 2578	1,934 (75)	240 (75.7)	1,694 (74.9)	0.815
Age, years	42 [27–59]	45 [29–62]	42 [27–58]	0.055
Season, winter	674 (26)	80 (25)	594 (26.2)	0.709
Type of injury, n = 2,256				
Blunt trauma	2,406 (94.1)	304 (95.9)	2102 (93.9)	0.193
Penetrating trauma	150 (5.9)	13 (4.1)	137 (6.1)	0.193
Mechanism, n = 2,563				
Road collision	1,472 (57.4)	211 (66.6)	1261 (56.1)	0.001
Car occupant	602 (40.9)	102 (48.3)	500 (39.7)	0.021
Motorcycle	500 (34)	61 (28.9)	439 (34.8)	0.112
Bicycle	124 (8.4)	24 (11.4)	10 (7.9)	0.125
Pedestrian	238 (16.2)	20 (9.5)	218 (17.3)	0.006
Fall[a]	542 (21.2)	55 (17.4)	487 (21.7)	0.091
Suicide	195 (8.7)	21 (7.2)	174 (8.9)	0.397
Gunshot/stab wounds	117 (4.6)	9 (2.8)	108 (4.8)	X
Other[b]	432 (16.9)	42 (13.3)	390 (17.4)	0.079
Prehospital time (minutes)				
On-scene time[c]	36 [26–51]	34 [24-48.5]	36 [26–52]	0.009
Journey time from scene to hospital	20 [13–30]	21 [14–30]	20 [13–30]	0.828
Total prehospital time	60 [44–82]	57.5 [41-75.25]	60 [45-83.25]	0.013
Type of transport				
Helicopter transport	550 (21.2)	42 (13.1)	508 (22.4)	< 0.001
Ground	2,041 (78.8)	278 (86.9)	1,763 (77.6)	< 0.001

Characteristics	Total population (n = 2,591)	Undertriage (n = 320)	Correct triage (n = 2,271)	p-value
Prehospital clinical data				
Heart rate (beats per minute)	90 [75–106]	90 [75–108]	90 [75–106]	0.813
Systolic blood pressure (mmHg)	125 [109–142]	124 [109–140]	125 [109-142.5]	0.527
Respiratory rate (breaths/min)	18 [15–20]	20 [16-20.25]	18 [15–20]	0.006
SpO2 (%)	98 [94–99]	97 [94–99]	98 [94–100]	0.015
Shock index	0.7 [0.6–0.9]	0.7 [0.6–0.89]	0.7 [0.6–0.9]	0.678
Glasgow coma score, n = 2,441	14 [7–15]	15 [10–15]	14 [7–15]	0.002
< 15	1,303 (53.4)	136 (45.6)	1167 (54.5)	0.005
≤ 8	696 (28.5)	64 (21.5)	632 (29.5)	0.005
Haemoglobin (g/dl)	13.5 [12-14.8]	13.1 [11.6–14.7]	13.5 [12-14.9]	0.056
Prehospital MMT procedures				
Endotracheal intubation, n = 2,353	949 (40.3)	74 (26.2)	875 (42.3)	< 0.0001
Thoracostomy, n = 2,337	60 (2.6)	5 (1.8)	55 (2.7)	X
Chest tube insertion, n = 2,337	28 (1.2)	2 (0.7)	26 (1.3)	X
Pelvic binder placement, n = 2,336	326 (14)	42 (15.1)	284 (13.8)	0.637
FAST, n = 2,333	400 (17.2)	9 (3.2)	391 (19.1)	X

Statistics presented: n (%); median [IQR]; X indicates limited statistical power (< 10 patients per group). FAST: Focused assessment with sonography for trauma

[a]Among the 542 falls described, 474 (87.4%) were from high height (> 5 meters), others were from “low height” (< 5 meters). Among those, 7 were “fall from standing”.

[b]The “other” category referred included cases such as animal horn, crushing by various objects, work accident with machines.

[c]From MMT arrival on-scene to departure

Table 2
Injury characteristics and outcome

Characteristics	Total population (n = 2,591)	Undertriage (n = 320)	Correct triage (n = 2,271)	p-value
Trauma scoring				
ISS	25 [18–34]	22 [17–29]	25 [19–34]	< 0.0001
MGAP score, n = 2,556	24 [20–27]	25 [21–28]	24 [20–27]	0.029
Severe injuries (AIS ≥ 3)				
Head	1,388 (53.6)	164 (51.3)	1,224 (53.9)	0.407
Face	128 (4.9)	9 (2.8)	119 (5.2)	X
Thorax	1,402 (54.1)	177 (55.3)	1,225 (53.9)	0.688
Abdomen	569 (22)	52 (16.3)	517 (22.8)	0.010
Extremities	923 (35.6)	89 (27.8)	834 (36.7)	0.002
Skin	23 (0.9)	3 (0.9)	20 (0.9)	X
Outcome				
ICU admission, n = 2,454	2,011 (81.9)	262 (86.5)	1,749 (81.2)	0.033
In-hospital mortality, n = 2,134	351 (16.5)	43 (18.3)	308 (16.2)	0.473

Statistics presented: n (%); median [IQR]; X indicates limited statistical power (< 10 patients per group); AIS: Abbreviated Injury Scale. ICU: Intensive Care Unit. ISS: Injury Severity Score. MGAP score: Mechanism, Glasgow coma score, Age, arterial Pressure score

Factors associated with undertriage

Our multivariate logistic regression analysis showed that patients aged 51–65 years had a greater risk of undertriage than those aged 18–30 years (OR = 1.60, 95% CI [1.11;2.26], p = 0.01); there was a non-statistically significant trend towards a greater risk of undertriage among oldest age groups. Conversely, patients who sustained a fall from height (OR = 0.62, 95% CI [0.45;0.86], p = 0.01) or gunshot/stabbing wounds (OR = 0.45, 95% CI [0.22;0.90], p = 0.02) were at lower risk of undertriage compared to those who sustained a road collision. A prehospital care duration ≥ 60 minutes (compared to 0–30 minutes: OR = 0.62, 95% CI [0.40;0.95], p = 0.03), a prehospital endotracheal intubation (OR = 0.53, 95% CI [0.39;0.71], p < 0.001) and a prehospital FAST (OR = 0.15, 95% CI [0.08;0.29], p < 0.001) were also factors associated with a lower risk for undertriage (Fig. 3).

Association between undertriage and mortality

Mortality was not significantly different between under- and correct-triage groups (18.3% vs 16.2%, p = 0.473). Our logistic regression found that undertriage was not significantly associated with a greater risk of in-hospital mortality (OR = 1.22, 95% CI [0.80;1.89], p = 0.36).

Discussion

In the present study, the undertriage proportion was more than twice as high as the ACSCOT's recommended < 5%[16], which is similar to that reported in other European and American studies [17–19]. Several authors have reported even higher rates of undertriage. Indeed, in a similar EMS system (physician-led), Bouzat *et al.* reported that 18% of included patients were undertriaged [7]. In paramedic-led prehospital systems, undertriage was also higher: Voskens *et al.* (Neverthelands) reported a 21.6% proportion of undertriage [17], Schellenberg *et al.* (USA) 16% [18] and Xiang *et al.* (USA) 34% [19]. Therefore, our physician-led prehospital system showed similar or better triage performance compared to other paramedic-led systems. However, since the definition of undertriage is heterogeneous in the literature, estimating and comparing the true undertriage rates between studies is difficult. Indeed, in 2019, a systematic review reported four definitions of undertriage: based on ISS, formula for mis-triage, need for life-saving emergency intervention, and patients triaged to a non-trauma centre [6] .

Herein, all patients older than 30 years of age were at greater risk of undertriage, and this was particularly significant for those aged 51 to 65 years. We cannot exclude insufficient statistical power to explain why age above 65 was not significantly associated with undertriage. Nakahara *et al.* reported a similar result; a trend towards a greater risk of undertriage for older patients, significant for the 45–54 year age group[20], and most studies also reported that age was a predictive factor of undertriage: ≥ 55 years[19], ≥ 65 years [1, 2], ≥ 80 years[21]. This is a particularly important issue as improved outcomes for older adults admitted in centers with higher levels of trauma care designation have been reported [22, 23]. A specific triage protocol to identify high-risk geriatric injured patients could further be explored, as it was found to lead to significant lower mortality [24]. Interestingly, we found that patients who sustained gunshot/stab wounds had a lower risk for undertriage compared to those involved in a road collision. This is in line with Schellenberg *et al.*'s results which reported a higher risk for undertriage following a blunt trauma, especially in motor vehicle collisions[18]. Although it is not entirely clear why, it may be explained by the fact that the injury severity of a penetrating trauma may be more obvious for prehospital caregivers (i.e., external haemorrhage, limb amputation) compared to blunt trauma. Furthermore, European physicians are less exposed to penetrating trauma compared to the numbers reported in US studies [25–27].

An original finding of this study is that patients who had a prehospital FAST were at lower risk of undertriage regardless of the severity of their injuries. Ultrasound-based clinical algorithms might improve the assessment of injured patient, but their effectiveness in the prehospital setting lacks evidence [28]. We assume that fluid detection influenced physicians to consider patients as requiring a higher level of care; another hypothesis is, however, that physicians performing FAST had more experience and better assessment capacities. The value of FAST in our field triage algorithm needs to be further and specifically explored.

Another interesting finding is that fewer patients transported by helicopter were undertriaged. This might be explained by higher availability of helicopter emergency medical services (HEMS) in level-I centres. Nevertheless, there was no significant association between the type of transport and in-hospital mortality, which is in accordance with that reported elsewhere [29,30]. We also found that prehospital on-scene management ≥ 60 minutes was associated with lower undertriage compared to faster management (0–30 minutes), regardless of patients' severity (ISS) and prehospital ALS performed. Nevertheless, there was a very small difference in on-scene times between under- and correct-triage groups, which is of limited clinical significance. Hence, those results cannot support systematic longer on-scene time.

In the present study, there was no significant association between undertriage and in-hospital mortality, compared to that reported elsewhere [1,2,31]. This may partly be due to the relatively small sample size. Of note, a large proportion of undertriaged patients were admitted to level-II centres that offer a wide range of 24-hour in-house resources (intensive care, general and orthopaedic surgeons, emergency physicians, embolisation, CT scan). Hence, a patient not requiring neuro- or cardiothoracic surgery could be properly managed in a level-II centre.

The study does, however, have some limitations. Its retrospective design means that it is not immune to data collection mistakes. The exact locations of the on-scene traumas were not available in the database, and we could not therefore evaluate the distance to the nearest trauma centre, which may have played a significant role in the choice of destination. Furthermore, triage may have been influenced by other elements that were not collected (i.e., chronic conditions, trauma centre overcrowding, a decision of withdrawing treatments, futility or family/patient wishes). Even if our definition of undertriage is validated by the ACSCOT[5], it may also be argued whether ISS is the most accurate tool for assessing whether a patient required level-1 trauma care compared to a clinical definition based on the need for critical intervention (i.e., urgent surgery, massive blood transfusion, craniectomy, or secondary transfer). .

Further research is needed in our regional physician-led prehospital system to improve the triage of major trauma patients. More specifically, the integration of systematic FAST on-scene should be evaluated in such EMS system. Refining undertriage definition should also be considered in similar EMS systems to fit local trauma system organization.

Conclusion

In our region-wide, physician-led prehospital EMS system, undertriage in major trauma was higher than recommended and advanced age was associated with higher risk for undertriage. Conversely, a pre-hospital FAST was associated with a lower risk for undertriage. Specific triage procedures should be discussed in older trauma patients and further studies are needed to evaluate the impact of prehospital FAST on triage performance. We noted that undertriaged patients had no higher risk for mortality suggesting no impact of secondarily transfer and/or high trauma care quality in level-II trauma centres. Undertriage definition should be tailored to fit local trauma systems organization.

Declarations

Ethics approval and consent to participate

All patients treated by the MMT received written information about the objectives of the trauma registry in accordance with French legislation and are given the opportunity to refuse inclusion. The registry received approval from the national data protection commission (*Commission Nationale de l'Informatique et des Libertés*, CNIL; number DE-2012-059), and received approval from the Advisory Committee on the Treatment of Research Information (*Comité consultatif sur le traitement de l'information en matière de recherché*, CCTIRS).

Consent for publication: Not applicabale

Availability of data and materials: Data are available upon reasonable request at c.claustre@resuval.fr

Competing interests: Authors do not declare any conflict of interest for this original article

Funding: Authors did not receive any funding for this work.

The trauma registry is funded by the Regional Agency for health (ARS, *Agence Régionale de Santé Auvergne Rhône-Alpes*) and coordinated by the RESCUe-RESUVal.

This research did not receive any specific grant.

Authors' contributions

AB: Literature search, study design, data collection, data interpretation, writing

LF, CC: Study design, data analysis, critical revision

MH, ME, EM, VB: Critical revision

EC, AG, JSD, CEK: Data collection, Critical revision

KT: Literature search, study design, data collection, data interpretation, writing

Acknowledgements:

We thank Julie Freyssenge, health geographer PhD, for providing the map of trauma centre and Philip Robinson (DRCI, Hospices Civils de Lyon) for help in manuscript preparation. We thank the local investigators of the trauma registry: Antoine Blum (SMUR 26, Saint Vallier), Bastien Anette (SMUR 69, Villefranche-sur-Saone), Djamel Bekka (SMUR 07, Privas), Eric Cesareo (SMUR 69, Lyon), Marine

Demarquet (SMUR 01, Bourg-en-Bresse), Patricia Trinquet (SMUR 38, Vienne), Stéphane Blain (SMUR 01, Ambérieu), Thomas Paita (SMUR 38, Bourgoin-Jallieu), Johan Restier (SMUR 26, Valence), Olivier Debas (SMUR 01, Belley), Raphael Brilland (SMUR 69, Tarare), Nicolas Roumestand (SMUR 26, Montélimar), Xavier-Jean Taverna (HEH), Jean-Stéphane David (CHLS), Etienne Javouhey (HFME), Loïs Grattier (CH Valence), Frédéric Verbois (CH Villefranche-sur-Saone), Patrice Serre (CH Bourg-en-Bresse).

Abbreviations

AIS
Abbreviated injury scale
EMS
Emergency medical services
FAST
Focused assessment with sonography for trauma
GCS
Glasgow coma scale
ICU
Intensive Care Unit
ISS
Injury severity score
MMT
Mobile medical team
SAMU
Service d'aide médicale d'urgence
SMUR
Service mobile d'urgence et de réanimation

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Figures

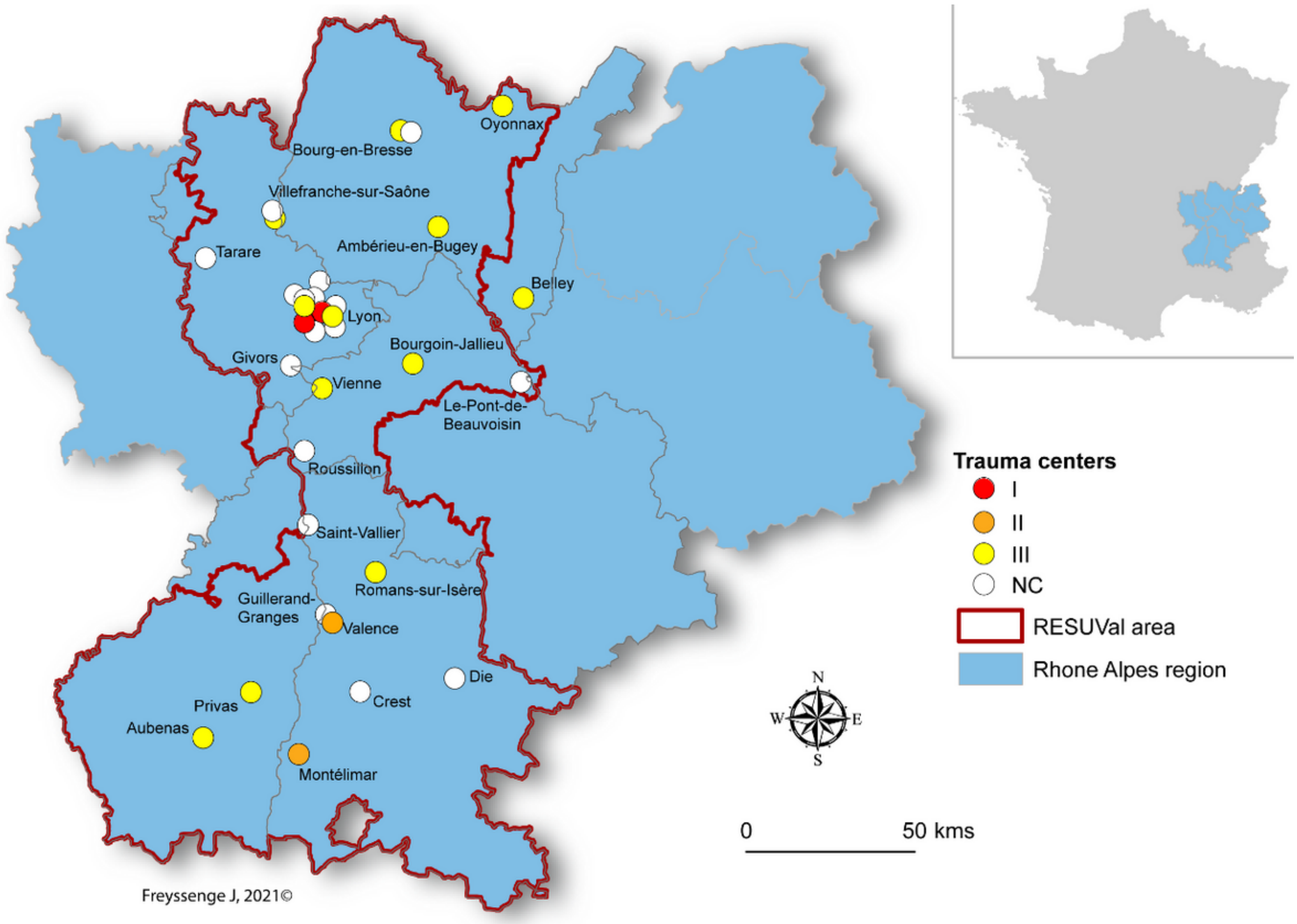

Figure 1

Trauma centre in the study area

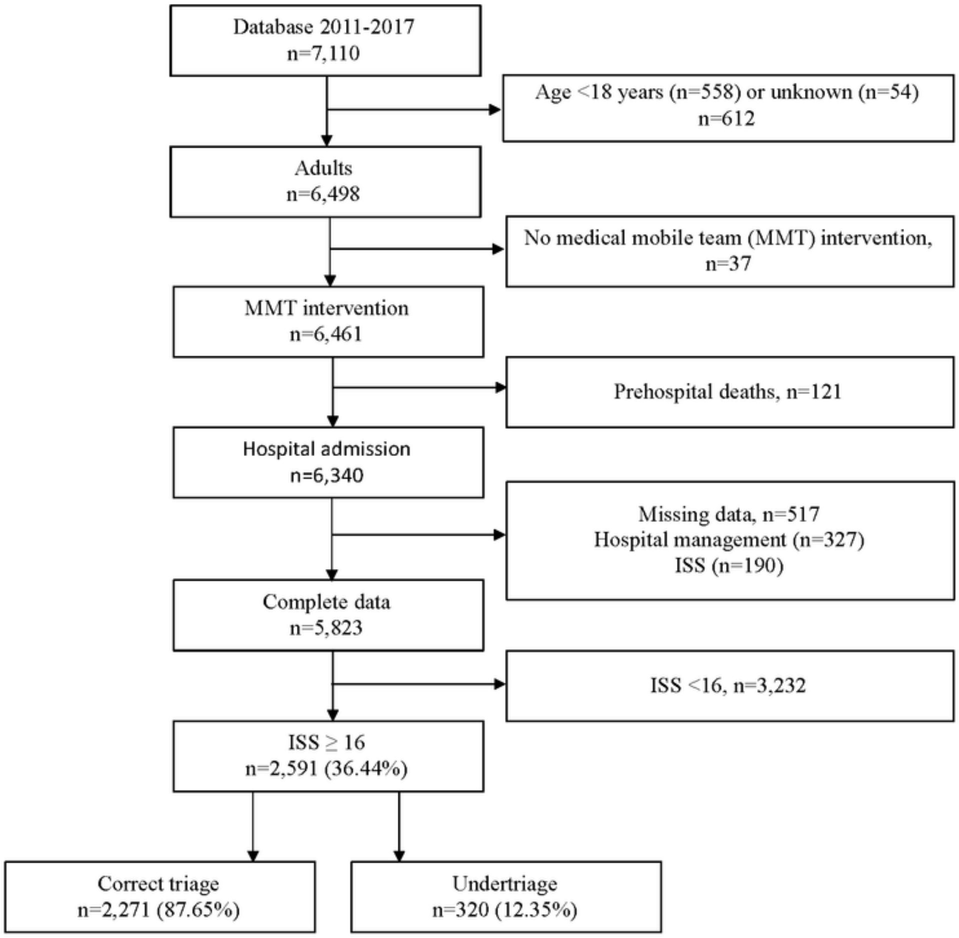

Figure 2

Flowchart of the study

Legend: ISS: Injury severity score

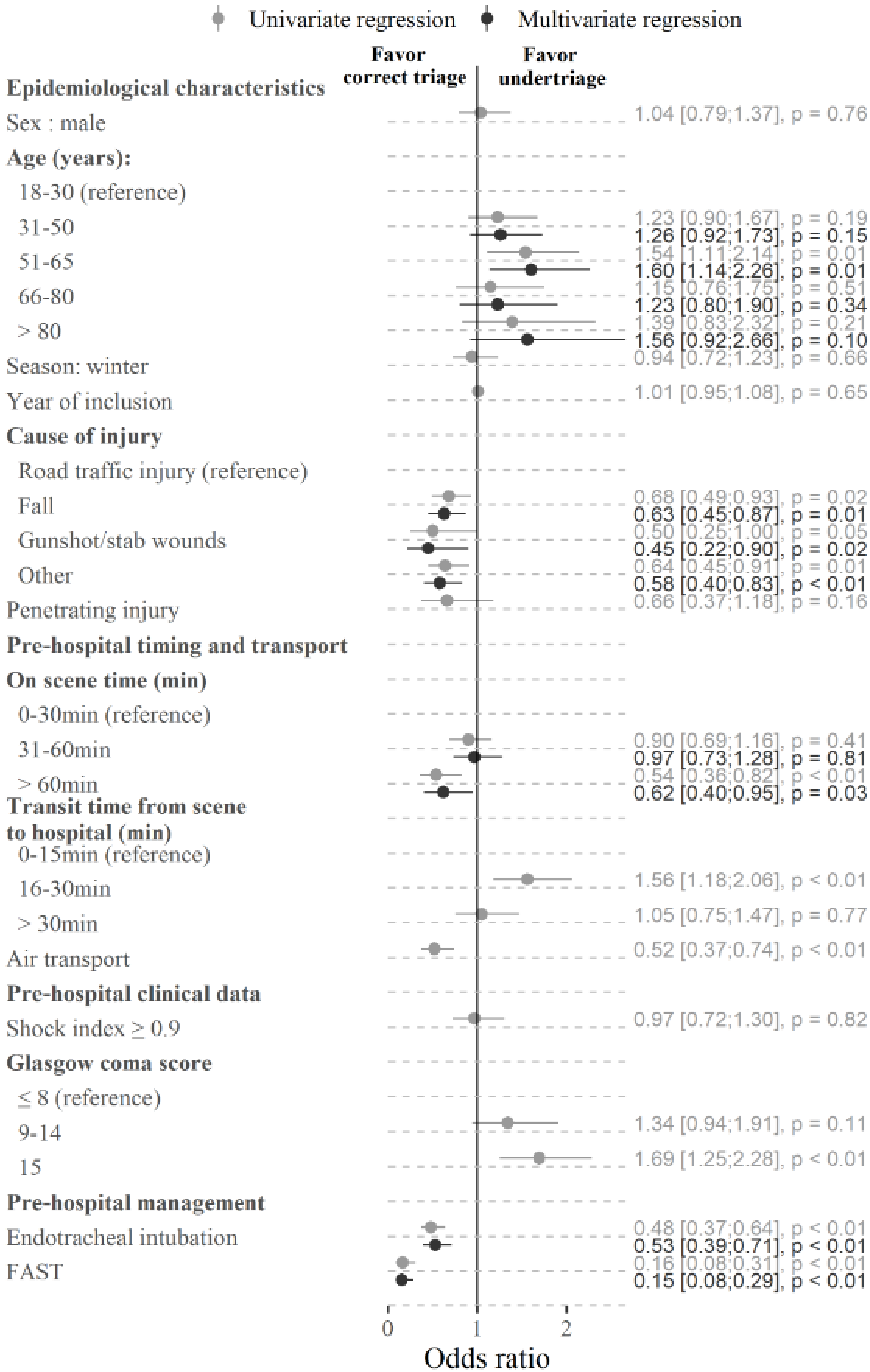

Figure 3

Determinants of undertriage

Legend: FAST: Focused assessment with sonography for trauma

Supplementary Files

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- SupplementalMaterialFigure1.pdf
- SupplementalMaterialTable1.docx
- SupplementalMaterialTable2.docx