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Original Article

Strategic proposal for a national trauma system in France

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ABSTRACT

In this road map for trauma in France, we focus on the main challenges for system implementation, surgical and radiology training and upon innovative training techniques. Regarding system organisation: procedures for triage, designation and certification of trauma centres are mandatory to implement trauma networks on a national scale. Data collection with registries must be created, with a core dataset defined and applied through all registries. Regarding surgical and radiology training, diagnostic-imaging processes should be standardised and the role of the interventional radiologist within the trauma team and the trauma network should be clearly defined. Education in surgery for trauma is crucial and recent changes in medical training in France will promote trauma surgery as a specific sub-specialty. Innovative training techniques should be implemented and be based on common objectives, scenarios and evaluation, so as to improve individual and team performances. The group formulated 14 proposals that should help to structure and improve major trauma management in France over the next 10 years.

1. Introduction

Major trauma remains a leading cause of death and disability worldwide, and particularly so among young and economically active adults in industrialised countries. It is the third highest cause of loss of disability adjusted life years after cancer and cardiovascular diseases globally [1]. The socio-economic impact is considerable and represents a public health challenge both worldwide and in France. Despite being a visible challenge, the funds and resources attributed to research, care and to the prevention of major trauma are discordant with its social impact [2]. This discrepancy is all the more surprising when compared to resources typically available for other acute pathologies such as cardiac arrest, stroke or maternal health. From this perspective, major trauma can be considered a neglected disease.

Establishing regional Trauma Systems in the United States [3,4], the United Kingdom [5,6], Germany [7,8] and Norway [9] has improved severe trauma management in these countries. When embedded into global and national policies and accompanied by significant political will amongst health professionals, civil society and public institutions [10], such trauma systems perform the following functions:

- developing research and prevention strategies;
- organising major trauma patient management and care at a regional and national level;
- standardising and homogenising healthcare professional training and care in major trauma;
- improving survival and medium and long-term functional outcome in trauma patients;
- reducing hospital length of stay and overall cost;
- optimising and facilitating access to rehabilitation facilities.

Beyond trauma, experience in the aforementioned countries has demonstrated a structuring effect of formalised trauma systems upon emergency care, acute medical care and acute surgical care across the board, as well as in exceptional circumstances such as mass disaster and terrorist attacks.

Despite the socio-economic impact of trauma, very few developed countries have yet enacted a national trauma plan. This is surprising and discordant with other specialties, notably obstetrics and organ donation, where national networks are common. France lacks a national comprehensive major trauma policy. Regional trauma systems do not exist, with a few laudable exceptions. The time is ripe to develop a comprehensive national strategy and recently, a symposium was held at the Grenoble University Hospital from the 21st to 22nd of November, 2017 in Grenoble, France. Its aim was to bring together stakeholders and to federate existing initiatives in the field of trauma care in France. The symposium promoted joint reflection and discussion around three main topics:

I) trauma systems-networks and a national trauma registry;
II) changes in trauma surgery and radiology practice;
III) simulation and innovative training techniques.

The results of these exchanges led to 14 specific proposals that are summarised in the present document. These proposals are not hard recommendations but intended as foundations of a future national trauma policy. They are based on expert opinions from each sub-group and were validated by the Groupe d'intérêt en traumatologie grave (GITE group).

2. Method

The symposium brought together 44 participants from all over France, representing the following scientific societies: Société française d'anesthésie et de réanimation, the Société française de médecine d'urgence, the Société française de chirurgie viscérale, the Société française de chirurgie traumatologique, and the Société française de radiologie. The selection of these experts was based upon their expertise, level of publication and their experience in trauma care.

The participants formed three working groups:

- trauma systems-networks and a national trauma registry;
- changes in trauma surgery and radiology practice;
- simulation and innovative training techniques.

Each working group agreed on a list of proposals and consensus statements. These were presented in a plenary session and openly discussed and improved if required. For each working group, a leader was designated to contribute to a final draft of all proposals in a single manuscript based on the initial consensus. A writing committee drafted and shared with all participants' 28 proposals; these proposals were collectively and repeatedly re-edited. The 28 proposals were again reduced to 21 questions to provide a formalised consultation process to retain in the end 14 key propositions.

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More than 70% of participants were needed to cast a vote on a proposition to consider the vote as valid. The participants expressed agreement on a scale from 1 to 9, with "9" corresponding to a complete agreement and "1" corresponding to no agreement. An agreement was considered strong, if more than 70% of respondents expressed a strong agreement, grade 7–9. If no agreement or only weak agreement would be reached on a proposal, an amended version of the proposal would be submitted to a second vote. If the second vote indicated no agreement, the proposal would be dropped.

Only complete questionnaires were taken into account. All questions required a response. More than 82% of participants completed the questionnaire and this resulted in an approval rate of 72% for all propositions formulated.

2.1. National oversight, trauma network and accreditation

2.1.1. Proposal 1: evaluation and coordination at a national level

National oversight and coordination in the form of a national trauma committee for any national trauma initiative involving all stakeholders is paramount to succeed. This committee must be embedded or attached to existing lead government agencies at national level and it may be necessary to create a new agency. Such a committee ought to be composed of representatives from government, civil society and a broad range of medical and non-medical professions and specialities (nursing, anaesthesia and critical care, emergency medicine, surgery, radiology, paediatrics, haematology, transfusion medicine and rehabilitation) all implicated in the care of trauma patients to generate a constructive dialogue. Endorsement by the principal scientific medical societies appears a prerequisite for legitimacy. This national committee should establish a list of process and key performance indicators that can guide the benchmarking and centre-accreditation process (see Proposal 6).

Existing trauma care and research networks and initiatives could serve as template for a national trauma initiative and greatly benefit from federation. Such a federation does not imply a merger but intends rather to develop shared synergy, increasing the legitimacy of existing networks and strengthening of a national initiative. Any national trauma initiative should be based on the principle of subsidiarity, meaning that in practice, no decision should be made and no function performed at a higher or more central level than can be accomplished at a more local level. Fig. 1 illustrates how the trauma patient pathway articulates with a national trauma initiative.

Three working groups are required to further to explore and develop the national priorities and policies:

- national trauma policy, network structure and accreditation process;
- National Trauma Registry;
- training and education.

These groups are supposed to develop more detailed proposals that can feed into a National Trauma Initiative under the auspices of a lead government agency.

Given that governmental financial and material resources are finite, constructive dialogue with lead government agencies and institutions will be required to advocate for further resource allocation. One obvious example not currently allowed for is that professional training and education needs to be considered as working time for both trainees and the instructors. The group shares the conviction that this dialogue is worthwhile and feasible.

2.1.2. Proposal 2: organisation of regional trauma systems and networks

Trauma systems and networks are best conceived at a regional level to optimise the assessment and allocation of resources [11,12]. This regionalisation process requires national consultation with government oversight and endorsement. Together, all regional trauma networks should cover the entire French territory; a territorial overlap between networks is acceptable and even desirable. Consultation involving prehospital, intra-hospital and rehabilitation trauma providers and services is important to

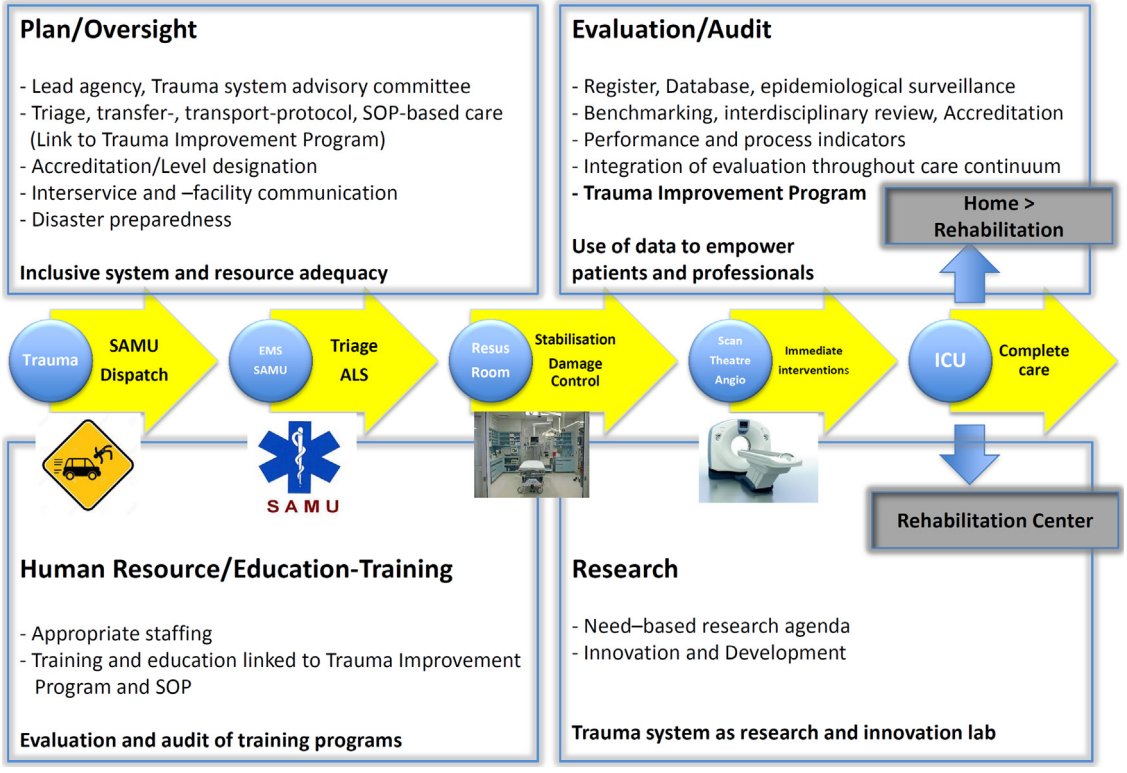

Fig. 1. Schematic view of the different proposals for trauma care in France.

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coordinate trauma care at the regional level [13,14]. Regional consultation requires supervision, empowerment and facilitation by the corresponding regional health authority (Agence régionale de santé, ARS) with legal power to arbitrate and impose rules where required. The process should lead to the appropriate use of rescue, prehospital and intra-hospital emergency services and to the shortest possible delays in prehospital transport, choice of transport vector (land or air) and admission routing to the most appropriate care facility given the clinical condition of the patient [15].

Regional trauma systems should adopt an inclusive approach in which every hospital with a 24/7 emergency department is included and assigned to a level of care and each facility provides a level of care that corresponds with local resources.

Patient needs are matched to a facility with an appropriate level of care and all centres have expeditious inter-facility transfer agreements with higher-level to be enacted where required due to evolving pathology. Such inter-facility transfers should be limited to an absolute minimum. Inclusive organisation helps maintain competence and skills in all facilities, limits the displacement of patients and their relatives and reduces saturation in level I centres.

2.1.3. Proposal 3: coordination, competence and resource management within regional trauma networks

Trauma management is by definition multidisciplinary and teamwork dependent. A broad range of professions (nursing, anaesthesia and critical care, emergency medicine, surgery, radiology, paediatrics, haematology, transfusion medicine and rehabilitation) and professional groups and medical specialties are crucial for the success of the trauma care process. The time constraint in trauma care mandate standardised and protocol driven care and interventions and lengthy consultation is counterproductive. Rapid, standardised responses include specific techniques that surgeons and radiologists need to learn and train for, in order to carry them out efficiently under all circumstances. The group deemed special attention is required to three key competences within a trauma network: general and trauma surgery, diagnostic and interventional radiology and rehabilitation medicine.

3. Trauma surgery

Within a given trauma network, a 24/7 to all surgical competencies and skills required for trauma care must be provided and including neurosurgery, paediatric surgery and cardiac surgery. The complete spectrum of surgical care should ideally be available at all level-1 centres without the need to transfer the patient. A specific paediatric trauma pathway is an integral part of any trauma network.

4. Diagnostic imaging

Trauma imaging is mainly based on ultrasound and CT scan; these techniques should exist in all hospitals participating in trauma care in France, but the 24/7 availability of contrast-enhanced CT requires organisation. The group is aware of a high degree of heterogeneity between centres and regions regarding CT scanner protocols and image interpretation. Unsecure non-standardised image transfer and patient data transfer are also problematic. In this context, it appears necessary to standardise CT-scan protocols at least within regions if not nationally. Radiologists will need to be identified within regional networks that are willing to contribute to this process of consultation and standardisation. Coordination will also be required at a regional level to mandate a standard whole-body scan protocol. Specifications for gated, ECG-synchronised acquisition of chest and large vessel imaging are also required to compensate for movement artefact. Such standardisation also implies secure image and data transfer systems providing images with sufficient quality in compliance with international standards (e.g. PACS-NEXUS ORTIF). Joint interpretation by intensivists, radiologists and surgeons should be encouraged to facilitate adhesion to therapeutic strategies.

Within a regional trauma network, radiological diagnostic quality and performance needs to be assessed and monitored. This can be performed via regular visits from level-I referral centre experts, for example, when attending joint mortality and morbidity reviews. Such visits are meant to provide positive educational stimulation and opportunity for exchange, training and network development and may be part of an ongoing certification process. The contribution of artificial intelligence to facilitate data and image interpretation requires further research and evaluation.

5. Interventional radiology

The group highlights the role of interventional radiology for the management of patients with severe trauma. The interventional radiologist must actively participate in therapeutic decision making alongside the surgeon and the anaesthesiologist, rather than just performing procedures on demand. The first step will be to identify all interventional-trained radiologists at each level-I centre and their attendant peripheral hospitals. Each region should then engage in a consultative process aiming to standardise radiology practice and training, to mutualise resources and to prepare respective staff. In the case of impossibility of transfer to a level-I facility, mobile interventional teams consisting of a trained radiologist and a radiology technician may be deployed to peripheral hospitals to perform radiological interventions in facilities without such capacity.

6. Rehabilitation medicine

It is vital for future trauma networks to improve and strengthen the link between hyper-acute and acute trauma care and medium and long-term rehabilitation medicine and re-education and social aspects of care including support to next of kin of trauma patients. This link will prove vital if trauma care is to be taken to the next level and improve long-term functional outcome.

6.1. Proposal 4: triage and dispatch system

The most well-known triage system in France is the Vittel Triage Criteria [16]. The Vittel criteria consistently identify severe trauma patients but are not discriminating enough to triage to the most appropriate level of care. Alternative and more sophisticated triage systems have been validated in regional trauma organisations in France such as the triage tool available in the Auvergne-Rhone-Alpes (ARA) region [17]. The ARA triage tool (Figs. 2 and 3) includes both the Vittel and ACSCOT criteria but differentiates three grades of decreasing severity (A, B and C), which are mutually exclusive and allow for adequate prehospital triage. It may well be useful to develop or validate a new national triage tool. A national tool could be adapted to regional needs and specificities. In any case, within a regional trauma system, all actors should agree on simple and concise triage rules to match patient severity to the appropriate level of care. Any such triage algorithms should be continuously evaluated for performance improvement. In the near

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Grade A: *instable despite resuscitation*

- Systolic arterial pressure < 90 mmHg despite the use of vasopressors and/or more than 1.5 L crystalloid fluids
- SpO2 < 94% despite the use of mechanical ventilation or the use of facial mask with high-flow oxygen
- GCS ≤ 8 or motor GCS ≤ 4

Grade B: *stablilized after prehospital resuscitation or anatomic criteria*

- Systolic arterial pressure > 90 mmHg or SpO2 > 94% after initial resuscitation
- GCS 9 -13
- Suspicion of spinal cord injury
- Positive extended-FAST
- Suspicion of severe pelvic injury
- Severe limb injury (amputation or crushed limb)
- Penetrating injury to haed / neck / trunk

Grade C: *Stable with high-kinetic circumstances or medical history*

- Fall from more than 6 meters, ejected/Projected/Blasted victim;
- Death in the same vehicle
- Assessment of speed accident: vehicle deformation, no seat belt, no helmet
- Fracture of two proximal long bones (femur/humerus)
- Medical history: <5 yrs or > 65 yrs, pregnancy, coagulation disorders

Fig. 2. Grading scale for on scene evaluation and triage of trauma victims available in the Auvergne-Rhone-Alpes region.

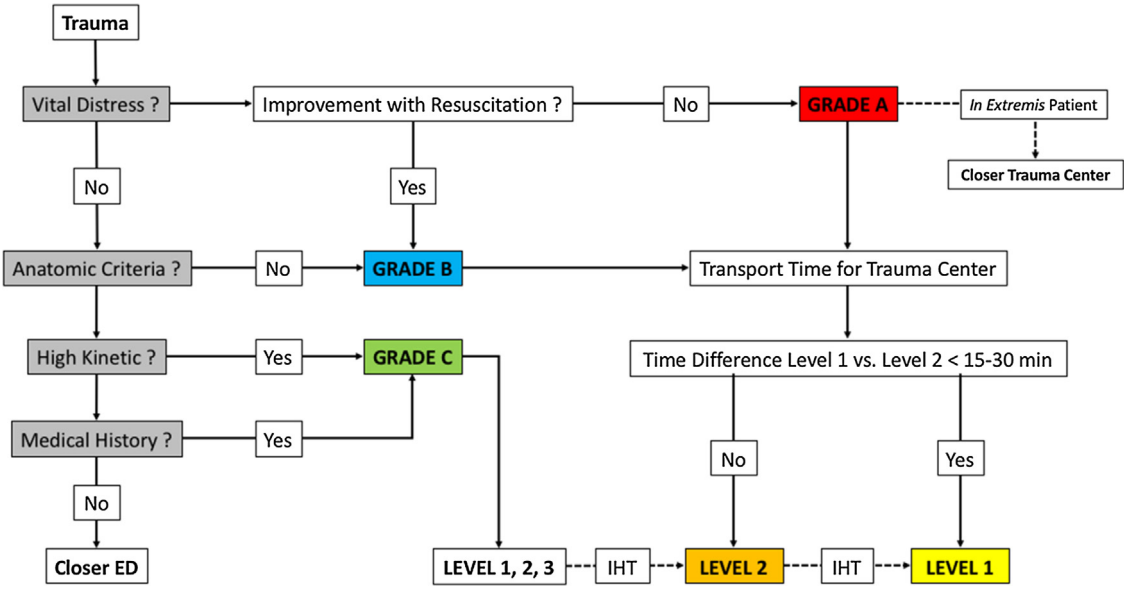

Fig. 3. Algorithm for triage according to the prehospital grade of injury severity and hospital classification available in the Auvergne-Rhone-Alpes region.

future, artificial intelligence will have a significant role to play in triage and dispatch.

6.2. Proposal 5: centre designation

Within a trauma system, all participating facilities require a designation based on their medico-surgical skill set, organisational competence and technical capacity to deal with major trauma. Centres with the highest level of trauma care will be designated level I. Level I centres are able to manage the most severely injured patients with complex and multiple injuries without need for transfer. A minimum volume of patients with an ISS > 15 is probably required for a level I centre to maintain collective skills and competence. This minimum volume remains to be defined and will be reconsidered for military centres where staff treats trauma patients in foreign military operations.

Centres with a less comprehensive level of care are designated level II. Level II centres are able to manage severe trauma, but not the most complex and severely injured patients. For example, a level II centre should probably be able to provide damage control surgery for initial haemorrhage control should transport to a level I centre exceed reasonable or predetermined time limits and transfer to a level I centre should be considered following damage control surgery. A level II centre should be able to provide a

complete imaging diagnostic workup, including contrast-enhanced whole-body CT scan. Volume of activity requirements should also apply to level II centres and such requirements also remain to be defined.

Depending on the infrastructure and geographical characteristics of a region, a third level may be designated, level III. A level III facility can manage non-severe trauma and should probably be able to provide a complete imaging diagnostic workup within a reasonable time frame in order to complete secondary triage.

The designation of centres and their respective levels should be the result of a regional consultation process inclusive of all stakeholders and supervised by the regional health authority. The consultation process should result in a detailed written agreement, which then becomes a regional reference document. There are no detailed definitive regional trauma system recommendations that fit all geographical and infrastructure circumstances. One size does not fit all. Transport modes, availability and times require specific solutions for each region. However, the designation of centres requires coordination within regional triage rules (see Proposal 2) and respond to regional needs. It should be pointed out that similar processes defining levels of competency have been successfully performed in most developed countries including France for many specialities over the last few decades, most obviously in obstetrics. Trauma hospitals require adequate funding and staffing. The volume of trauma activity in France in level I centres has probably been underestimated and is in consequence not sufficiently funded [18].

The group shares the consensus that in the current state of affairs, it is difficult to provide a detailed and definitive classification of Trauma Centre levels I–III. Table 1 provides a suggestion that requires consensus building at a National level. This also applies to issues of transportation and more advanced and detailed plans for regionalisation. These issues require institutional consultation at national level and are beyond the scope of this position paper and legitimacy of the study group.

6.3. Proposal 6: accreditation, key performance indicators, regional trauma improvement program

Centre designation should result from an accreditation process formalising structural requirements, national key performance and quality indicators (see Proposal 1). It is not immediately clear which body should perform this accreditation in France (see Proposal 1). Once again, it is of note that such accreditation, training and assessment processes exist in France for many other specialities such as organ donation and transplantation and obstetric care and other European countries have developed a sophisticated accreditation process to be used as a guide. In Germany, for example, the accreditation process is supervised by the Deutsche Gesellschaft für Unfallchirurgie (DGU) and the accreditation process performed by private institutes. Any accreditation process requires coordination with the existing legal and institutional framework in France and close coordination with all medical societies involved. In the existing institutional and political context before national consultation process, the study group considers it premature to provide recommendations which agency or organisation should supervise and perform the centre-accreditation.

Centre accreditation within a regional trauma system should imply a commitment to a structured trauma training program aiming towards improved objective performance, quality and process indicators. A regional steering committee can coordinate the regional trauma benchmarking and improvement program along the line of national targets and recommendations. Comprehensive regional data collection is a prerequisite for accreditation and the lead agency, notably the regional health authorities, has a critical role to play in enabling and empowering training and assessment. The participation in a national registry is mandatory for accreditation.

Table 1
Suggestion for trauma center level-I expertise and technical infrastructure. This classification is the actual classification of trauma centres in the Auvergne-Rhone-Alpes region and should be adapted in each regional network.

	Trauma centre Level I	Trauma centre Level II	Trauma centre Level III
Admission unit	TRU	TRU/ED	ED
Trauma team	Yes	Yes	No
Critical care	ICU	ICU	ICU or SDU
Specialised ICU*	Yes	No	No
Operating room H24	Yes	Yes	Yes
Anesthetist-intensivist H24	Yes	Yes	On call
General surgery H24	Yes	Yes	On call
Orthopedic surgery H24	Yes	On call	On call
Neurosurgery	Yes	No	No
Cardiac surgery	On call	No	No
Thoracic/vascular surgery	On call	On call	No
Ophtalmic/ENT	On call	On call	On call
Maxillofacial	On call	On call	No
urology	On call	On call	On call
Gynaecology/obstetric H24	Yes	On call	On call
Imaging within 30 min	CT/MRI	CT/MRI	CT
AE within 30 min	Yes	Yes	No
Massive transfusion	Yes	Yes	No
Mobile ICU ambulance	>2	At least 2	1
EMS Helicopter	>1	1	No
Helipad access	Yes	Yes	Yes
Major trauma (ISS >15)	>100	>50	–
Trauma research/education	Yes	No	No

AE: angio-embolization; EMS: emergency medical system; ENT: ear, nose and throat; ICU: intensive care unit; ISS: injury severity score; specialised ICU: burn-ICU, neuro-ICU, paediatric ICU.

6.4. National Trauma Registry

6.4.1. Proposal 7: rationale and framework for a National Trauma Registry

To respond to the public health challenge posed by major trauma, reliable data describing major trauma care in France are required. Currently, there is no exhaustive or comprehensive trauma data collection in place in France, whether at a national or a regional level, including data on patients dying out of hospital or in minor centres.

Trauma registries are indispensable and a national French Trauma Registry that maintains and extends existing prospective registries is a prerequisite for any national initiative. Reliable data are essential for the evaluation of the adequacy of resources and to identify risk and prognostic factors in individual patients. A National registry should be highly concordant with existing European datasets (Utstein 2008). Data from all three phases prehospital, intra-hospital and rehabilitation should be collected. Prehospital phase data should be relatively easily acquired given the impending national rollout of computerised medical regulation software (SI-SAMU). Centres with a research focus may establish an extended shared biobank.

A Registry Charta binding for all users will define among other aspects:

- the purpose and administrative framework;
- ethical aspects and patient consent;
- data governance, protection and ownership;
- access and use of the data.

Existing registries, the TRENAU Registry merged with the RESUVAL database [19], and the observatory, TRAUMABASE (Traumabase.eu) [20–23], provide a framework for these four

aspects for the National Registry to build upon. This framework can be incorporated into the National Registry.

The National Registry can be linked to administrative databases (Programme de médicalisation des systèmes d'information, PMSI, and death national registries) facilitating evaluation, benchmarking and research. These links would enable cross checking and improve data capture and completeness for major trauma. Automated data extraction from clinical or administrative information systems should be encouraged and facilitated. The use of advanced information technology and data analytics such as machine learning and artificial intelligence should be explored will most likely support this capacity. The legal and data governance implications of database links and automated exploitation and analysis require clarification.

6.4.2. Proposal 8: Trauma Registry objectives

The objectives of the National Trauma Registry ought to be stated in the aforementioned charter. Research objectives are embedded into a national research agenda (see Proposal 11). These objectives include:

- public health and policy objectives:
  - facilitate regional trauma system management,
  - describe the technical resources and strategies deployed in major trauma care,
  - analyse resource allocation and identify national inadequacies in major trauma management,
  - develop and follow clinical key performance indicators,
  - identify patterns and factors predictive of morbidity and mortality;
- to facilitate and enable observational and prospective research.

Different provider groups will have different objectives and require specific data to evaluate their progress. An academic level I centre will have different objectives and data requirements than a level II centre with low trauma activity levels. Regional health authorities require different data than hospitals. As a result, existing and future data collection systems need to respond to these diverse needs and objectives. Data collection will need to be robust and sustainable and public funding will be required.

Data submission to a regional or national registry should be mandatory and part of the designation process for all accredited centres (Proposal 6). Care must be taken to not overload health care providers with unrealistic data collection demands. Adding to the existing workload is a major obstacle to the development of formal trauma systems and to the development and extension of trauma registries and funding for clinical research technicians to perform data collection will be required. Professionals should have easy access to the data from both their centre and their region so as to inform and empower their clinical practice.

To optimise data collection, different strata of data collection sets should be envisaged. A core data set should be developed that responds to minimal regional and national epidemiological needs. The 2008 European Utstein Trauma consensus template data set may well fulfil these requirements. From this core data set, additional layers could be added according to ascending needs. For example, level I, level II, traumatic brain injury and haemorrhagic shock data sets may be added. The core data set must include as a minimum:

- the variables required to compute probability of survival, based on current scoring systems such as the TRISS score;
- basic outcome variables such as hospital mortality and length of stay.

The Registry should also include data on long-term clinical evolution (neurological outcome), socio-economic impact (return to work, next of kin input) and quality of life after trauma.

7. Research

7.1. Proposal 11: research and assessment

The national trauma initiative should set a national research agenda set along the lines of a recent international consensus (doi: 10.1007/s00134-017-4895-9. Epub 2017 Jul 29). Ideally, large-scale research efforts should be coordinated at a national level. The following non-exhaustive list provide a selection of priority questions and topics:

- which targets and indicators should be used for major trauma in France? Preventable deaths, under or over triaging, mortality reduction, and/or long-term functional outcomes?
- how should trauma networks be structured? What level of medico-surgical capacity is required for each designated level facility?
- provide national guidelines comparable to the National Institute for Clinical Excellence (NICE) guidelines in the United Kingdom [24];
- is there a need to optimise prehospital dispatch and triage? If so how?
- how to best deploy prehospital airborne transport vectors?
- what are appropriate criteria for damage control strategies?
- what is the place and need for hybrid resuscitation theatres in major trauma care?
- what specific measures need to be implemented regarding the increasing number of geriatric trauma cases?
- how to make best use of viscoelastic screening tests in coagulopathic patients?

A national database that summarises and maps ongoing trauma research, improvement and training programs and initiatives would be more than desirable. Collaboration with social and geographic scientists should be encouraged.

8. Training, simulation, assessment

8.1. Proposal 12: initial training and continued training

The aim is to develop standardised educational programs based on multi-disciplinarity and inter-professionalism, improved team-working and team decision-making in complex clinical situations [25]. Key questions that need to be answered are:

- what are the key and core skills required for the management of major trauma patients?
- how to practitioners acquire these skills?
- what is the best method of assessment of such key skills?

In order to develop a consensus-based standardised curriculum for major trauma management, a list of the key skills for healthcare professionals will be established. Each medical and nursing speciality will be asked to identify core skill-set.

Classical medical education focuses mainly on knowledge and individual technical and clinical skills. However, many other non-technical skills will strongly influence team performance and ultimately determine quality and safety outcomes [26]. Such non-technical skills are poorly taught in classical educational programs.

In France, recent changes in the national medical training curriculum will include specific trauma medicine modules. Such modules shared and jointly attended with other specialties should

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be developed and made available in initial (diplômes d'État d'études spécialisées, DES) as well as continuous medical education (développement personnel continu, DPC). Such modules should cover pathophysiology, technical skills required and clinical challenges of complex trauma, examples include the management of haemorrhagic shock, damage control resuscitation, and severe pelvic, liver or thoracic injuries. These modules should integrate joint simulation sessions to develop non-technical skills, team work and crisis communication facilitating multidisciplinary cooperation. Initial training for residents of all concerned specialties and medical professions and standardised multi-disciplinary and professional team training should be a mandatory accreditation criterion for trauma centres.

9. Initial or complementary trauma surgery training

French surgeons' level of interest in trauma surgery has been heterogeneous and inconsistent and variable according to surgical specialty. Since the recent terrorist attacks in Paris and Nice in 2015 and 2016, increasing awareness is palpable and the need for training and skill development has been emphasised (Société française de chirurgie d'urgence, SFCU, http://sfcu.univ-lyon1.fr). Some European countries offer the specialty training in the sub-specialty of Trauma Surgery (European Society for Trauma and Emergency Surgery [ESTES], http://www.estesonline.org). Many Medical Administrative Councils (CME) across the country as well as many surgeons have expressed the need for standardised initial and complementary training in trauma surgery for all surgeons working in acute care facilities in France across all surgical specialties.

Such training should adhere to a national curriculum and could easily be based upon the trauma surgery module pioneered by the military medical health service (services de santé des armées, CACHIRMEX training course, École du Val-de-Grace, Paris, and Principles of War Surgery, gestion d'enseignement à distance d'information du service de santé des armées GEDISS@ http://www.dev.gedissa.org). This module could be delivered during initial training to all general medical trainees and junior surgeons, as well as a refresher course or during continuous professional development to senior clinicians from all surgical specialties based on a core skill set (see above). Such a program would respond to the training needs expressed by clinicians and Medical Administrative Councils (CME) across the country.

For the initial training of general medical trainees and junior surgeons, theoretical teaching has been incorporated into the basic teaching in visceral surgery. Other surgical specialities need to follow this lead. Following the national reform of medical training, a war and disaster surgery module will be delivered to all surgical trainees, and in theory should be to all medical trainees in specialty training (DES, diplômes d'études spécialisés). This teaching incorporates practical team-based training simulation.

To ensure continued professional development in practicing surgeons, a modular approach should again be adopted. On the one hand, attendance at official training modules as described above may be encouraged. On the other, regional refresher courses may also be offered, although the latter will require consultation and development. Mobile training teams may be envisaged.

Long-term individual, institutional, financial and material encouragement and support will be required from regional health authorities to ensure sustainability. Surgical attendance could be a criterion for ongoing certification of trauma network facilities. One existing regional trauma network – TRENAU – has pioneered such an approach [19].

10. Interventional radiology training

The training of radiologists needs to evolve so as to incorporate this dimension, so that future generations of radiologists are trained as professionals in the trauma context. Current training is insufficient.

There are three levels of procedures in interventional radiology:

- level I, accessible to most radiologists, includes ultrasound-guided or CT-guided puncture, drainage or biopsy;
- level II includes more complex techniques such as embolization and revascularisation of peripheral vessels;
- level III corresponds to use of intracranial endovascular techniques or complex haemostatic procedures such as aortic endoprotheses.

Levels I and II are required in the vast majority of trauma cases treated in a mature trauma system. They should be a prerequisite for a level I trauma centre designation. Endovascular and percutaneous protocols are more homogenous than those used in diagnostic radiology. This can be explained by the fact that training is provided by just a few centres in France (DIU, École d'embolisation). Moreover, only a small number of radiologists perform these techniques (5% of all radiologists in French territories, or 450 clinicians). The financial incentive to acquire and deploy these skills is limited, since their compensation is low compared to their cost.

Interventional radiology (IR) training will be affected by the currently ongoing national reform of medical training (réforme du 3^{e} cycle). IR training will become a formal option within the radiology specialty-training template and will be delivered during the two-year consolidation phase.

10.1. Proposal 13: enhanced use of medical simulation and standardised simulation

Simulation is an educational tool used to improve quality and safety of practices in multiple situations [27]. It is currently expanding in medical training, is used to teach and train technical and non-technical skills, and to enhance teamwork and communication [28,29]. Simulation-based education methodology is well suited to major trauma care. Simulation-based pedagogy will provide both realism and interactivity, connecting basic science, clinical knowledge and procedural skills [30]. Training objectives will be defined aligned to the educational modules across medical specialties and health professions with standardised scenarios corresponding to individual and team skill sets. Interconnections between specialties and professions will be developed and encouraged in order to promote teamwork skills and to share resources. Those scenarios will cover both technical and non-technical skills. The design, rules and delivery of the scenarios will use standardised core language in order to promote a common pathway of skill acquisition during simulation sessions and obtain validation by a multidisciplinary expert group. Assessment grids will be designed according to previously defined individual, collective, technical and non-technical skills. Assessment grids may also help standardise debriefing procedures across simulation centres and reinforce the importance of debriefing in the learning process.

10.2. Proposal 14: assessment and improvement of individual and team performance

The curriculum for major trauma could be gradually integrated into medical and nursing specialty programs for all staff involved in severe trauma care and also include prehospital staff. It could

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Table 2
Summary of the different proposals from the Groupe d'intérêt en traumatologie (GITE) group.

Chapter	Proposal	Sub-proposal
(I) National oversight, Trauma-Networks, Accreditation	P.1 Coordination and evaluation by national oversight trauma committee attached to existing or new government agency implicating all trauma care stakeholders based on subsidiarity	National Committee, Policy and indicators Constructive dialogue Existing initiatives as template Resource adequacy
	P.2 Organisation of inclusive regional trauma networks based on regional consultation process	
	P.3 Coordination, competence and resource management within regional trauma networks including all health care providers and professionals groups	Special roles for General and trauma surgery Diagnostic imaging Interventional radiology Rehabilitation
	P.4 Need for regional triage and dispatch systems that extend existing algorithms; potential need for national algorithm	
	P.5 Center designation by health authorities based on concise national criteria into Level I–III	
	P.6 Center designation based on centralised accreditation program, follow up of standardised key performance and process indicators and implementation of regional trauma improvement programs	
(II) National Trauma Registry	P.7 National unified Trauma Registry as indispensable prerequisite for national trauma policy to allow estimation of needs, resource consumption and impact	Establishment of national Trauma Registry Charta Alignment with existing European Registries Link to administrative databases
	P.10 Clearly stated national objectives trauma registry and alignment with research agenda	Need based data collection with core and extended registry data set Mandatory participation for trauma networks and centers
(III) Research	P.11 National research agenda set by national trauma committee and continued scientific assessment of strategies and care	Develop innovation and multidisciplinary research
(IV) Training, simulation and assessment	P.12 Develop standardised educational programs based on multi-disciplinarity and inter-professionalism, improved team-working and team decision making in complex clinical situations	Initial or complementary trauma surgery training Interventional radiology training
	P.13 Enhanced use of medical simulation and standardised simulation	
	P.14 Assessment and improvement of individual and team performance	

then constitute a part of an accreditation process. This process must be validated step by step, providing recognised, validated and permanently updated assessment tools.

Standardised simulation sessions may be video-recorded and interchanged between trauma-centres. Individual and team performance assessments will be performed with the use of standardised assessment grids. Such a process will concurrently and independently assess and improve trauma care. The debriefing methodology used in the simulation environment can also be adopted in real time clinical major trauma care. Trauma teams will debrief employing clinical and non-technical assessment grids so as to guide and improve their own practice.

11. Conclusion

The development of the above proposals will require a concerted effort from all concerned professional stakeholders and from government institutions and civil society. Long-term commitment from all will be a prerequisite for success. The proposals are summarised in Table 2. Political and institutional support is crucial to make the effort sustainable and provide necessary conceptual, financial and material support. These proposals also highlight the role of the cooperation between civilian and military medical organisations. Once a national plan becomes a reality in France, European data gathering may be considered to provide a comprehensive picture of trauma care across the continent.

12. Ethical statement

Not applicable.

Disclosure of interest

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