Mass Casualty Management via an Artificial Intelligence Based Approach

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Mass casualty situations

Very often disasters result in **mass casualty situations**, when the number of casualties exceed the resources normally available from local resources.

3 main parameters – available resources, number of injuries, and severity of injuries – determine the **complexity of decisions** to be made at casualty collection points and advanced medical posts by local health services.

The decision-making process becomes complicated due to the fact that significant bleeding into the peritoneal, pleural, or pericardial spaces may occur without visible warning signs.

Triage of casualties – important element in disaster management chain.

Proposed solution

We propose to formulate, develop and implement **decision support framework** for management of mass casualty situations at collection points via an artificial intelligence based **multilayered approach**, aimed to support decision-makers (healthcare personnel and aides), who are dealing in a disaster area with a considerable number of casualties and have limited resources such as ambulances, available nearby medical centers, and personnel.

Our solution is focused on **reducing the number of victims** by implementing emergency ultrasound in injury assessment at disaster site using portable ultrasound scanners, and offering easy-to-use computer-aided tools for mobile devices, which will help to perform triage (based on vital signs).

Objectives

The main objectives of the proposed approach:

- Fast **assessment of triage priority** (based on vital signs) for casualties at collection points;
- More **accurate re-triage** of casualties with injuries of thorax and abdomen (taking into account level of urgency determined by emergency ultrasound);
- Suggest **efficient therapeutic decisions** (interventions and emergency diagnostics);
- Assist the **coordinated evacuation** of the injured persons by offering a guidance for rapid transportation.

Impact

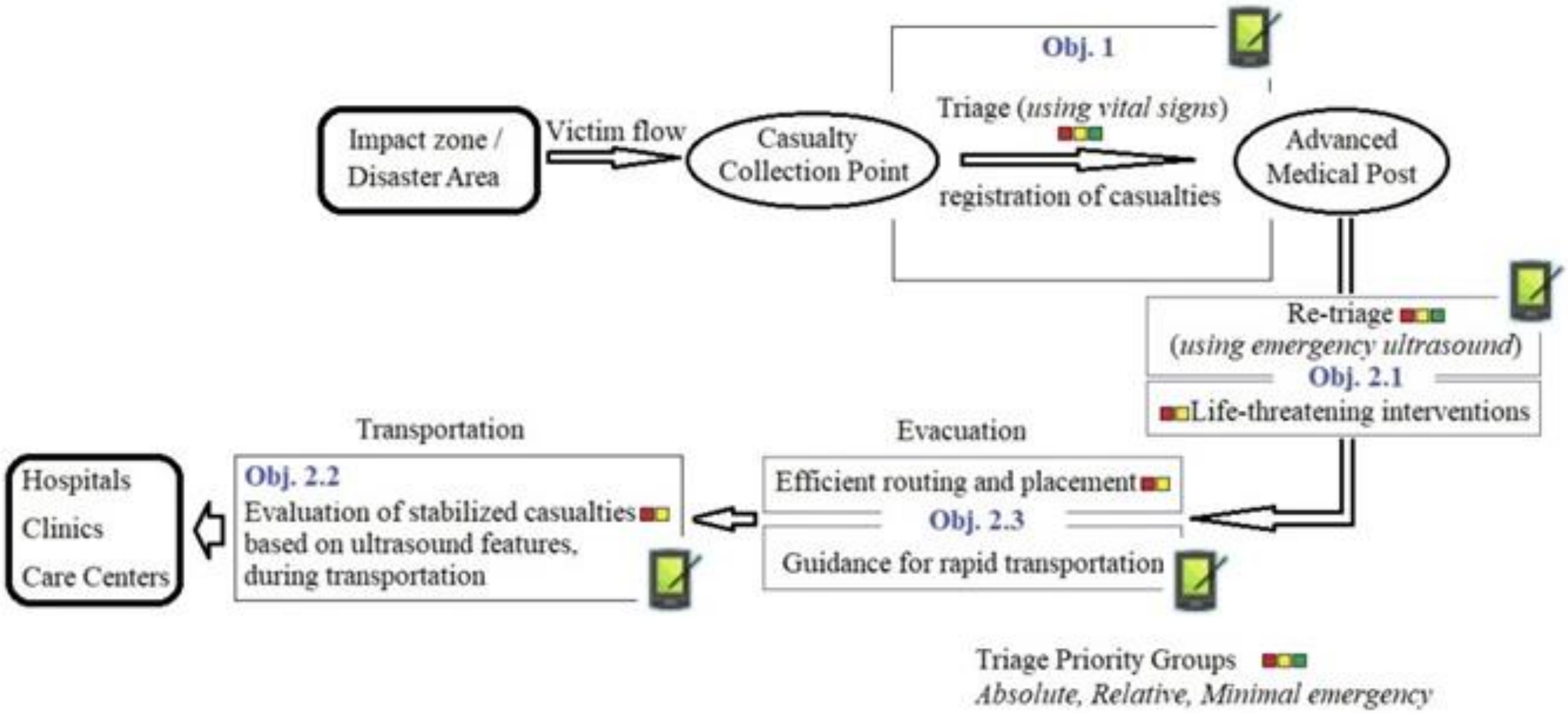
The developed decision support framework allows:

- to improve primary triage accuracy, based on vital signs;
- to make casualty re-assessment (at the discretion of sonographer and based on time availability) before a subsequent transportation;
- to make a more orderly evacuation process in mass casualty situations.

→ thus will **minimize over- and under-triage cases**.

Casualties flow management. Example scenario

Primary triage, based on vital signs, is the first and the most important stage of the mass casualty situations management:



Why AI?

Mass casualty situations are characterized by the **complexity of decisions** to be made at collection points.

Emergency doctors and paramedics **do not have the time** to perform a comprehensive and time-consuming evaluation of an organ and body system.

In most cases they are focused on free fluid determination because 40% of all trauma-related deaths are due to exsanguination.

AI algorithms and methods allow to create a knowledge based framework that can solve the complexity of the decision. AI technologies can take into account the **existing professional knowledge** (all levels of medical protocols) and **"good practice"** (experience in solving rare cases, described by real precedents).

Formalization of decision knowledge and reasoning in medical triage domain (I)

In collaboration with a team of **medical experts** in clinical emergency medicine, the minimum set of parameters needed for casualty registration was identified.

The medical record for **casualty registration** consists of: personal data, time interval, type of injury (resulting from visual inspection of casualty), values of 9 basic parameters that describe vital signs: visual inspection, Glasgow Coma Scale, airways, pulse, systolic and diastolic blood pressure, respiratory rate, oxygen saturation, individual mobility.

As the **knowledge representation schema** there was selected the tabular form (most often used in the field of emergency medicine).

Formalization of decision knowledge and reasoning in medical triage domain (II)

The **inference module**, which represent the formalized reasoning process, is based on decision rules, identified in collaboration with medical experts.

As the formalization schema of the decision rules there was used **symbolic rules (productions)** – being one of the most popular methods in the field of medical information systems and familiar for medical emergency crew from medical protocols.

Knowledge base kernel creation

There was developed a **web-module for data acquisition** – Medical Data Management Platform.

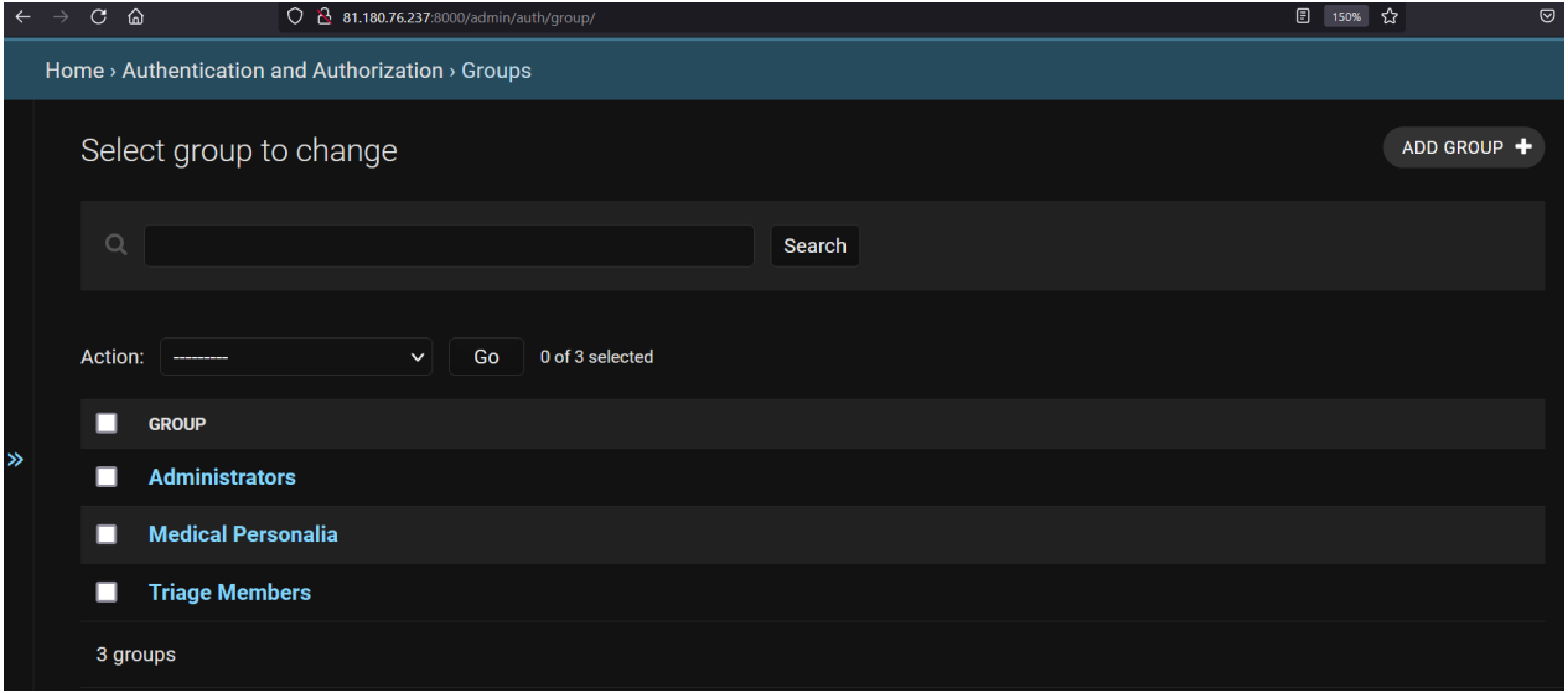
This platform allows to **record and storage data about the casualty state**, prioritizing them in 4 emergency categories (RED (I), RED (II), YELLOW, GREEN), based on vital signs.

The inference module is based on 4 decision rules.

All 4 rules were formalized and integrated into the inference module, representing now the **knowledge base kernel**.

To **validate** this result, we decided to create a synthetic data set and pre-test the decision algorithm.

Medical Data Management Platform



Approach for pre-testing. Conclusion

The obtained pre-testing result allows to state that the proposed approach is a viable one for creating an **efficient inference for casualty prioritizing**, based on vital signs.

Both the study of the problem domain and the obtained result showed the existence of a one-sided orientation in selection of the way to describe reasoning for casualty prioritizing – **algorithmic** (decision trees, decision rules, etc.) or **numerical** (tabular form, scoring system, etc.).

At first glance, this selection is determined by the type of data source and the data itself.

Another reason is the time available for decision making.

Future work

A deeper analysis of the obtained result allowed to make the following hypothesis: consciously or unconsciously the developers of medical information systems make their choice based on the restrictions imposed by the end-user habits – first-aid person and/or by the subdomain, in which the future information system will be used (disaster type like earthquake, chemical or nuclear accident, explosion, flood, etc.; restrictions by age or any anthropometric data).

To verify the formulated hypothesis, it would be interesting **to carry out both approaches – algorithmic and numerical** (including with a scoring system) for the same restrictions of problem subdomain and the same set of real cases, described with the same set of 9 parameters.

Support from RENAM (Moldova)

- Establish collaboration contacts with the researchers and policy makers interested in our topic from the other EaP countries;
- Share stakeholders' data for research purposes;
- If the volume of data and acquired knowledge exceeds the current storage and processing resources – need for Cloud resources;
- Guidance on FAIR data and Open Science (with OpenAIRE services, etc.).

Thank you!

Acknowledgments

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