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RESEARCH ARTICLE

Going the Full Circle: Upgrading the Patient Field Chart and Tag for Electronic Mass Casualty Incidents Solutions in Romania

Adrian Stănescu[1*], Sanda Maria Copotoiu[2], Cristian Marius Boeriu[3]

1. Sibiu Clinical Pediatric Hospital, Sibiu, Romania
2. University of Medicine, Pharmacy, Sciences and Technology of Târgu Mureș, Târgu Mureș Clinical Emergency County Hospital, Târgu Mureș, Romania
3. University of Medicine, Pharmacy, Sciences and Technology of Târgu Mureș, Romania

Objective: Mass casualty incidents and disasters require functional and efficient patient data management systems, as well as smart interconnections with patient tracking applications. Various initiatives developed and tested patient field charts for large-scale events but there is no one definite general format accepted. The current research proposes an upgraded model of the official patient field chart issued by the Romanian Department for Emergency Situations in 2015 to be used for large-scale events. **Measures**: An upgraded model is created after a thorough content analysis, physical analysis, design upgrade and optimization process. Differences between the official and the upgraded model are measured and compared, and statistical computations are carried out. **Results**: The main distinctive features of the patient field chart are dynamic triage, unique code identification, QR visual codes, wireless tags and irreversible clear contamination status highlighting. The upgrade process results in almost doubling the available active area without the need to change the document size format of the product. Visual elements and features are included to optimize operation workflow. **Conclusions**: The upgraded model offers a variety of improvements for both the overall rescue effort as well as the end user of the product. It allows for previously unavailable features like unlimited dynamic triage and enables the use of electronic management solutions.

Keywords: patient field chart, triage tag, dynamic triage, mass casualty incidents, electronic management

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Introduction

Mass casualty incidents (MCIs) and disasters require functional and efficient patient data management systems, as well as smart interconnections with patient tracking applications [1, 2]. While tracking features are mainly provided on a daily basis by medical transport systems in place, prehospital patient data management during large-scale events may be troublesome given the great amount of data to be input in a very compressed timeframe [3, 4].

The particularity of this type of events consists of the lack of usefulness of certain elements contained in the usual prehospital data charts and the critical necessity of other missing specific elements [5]. To this end, MCIs patient field charts (PFCs) need to have a dedicated identification code, a coding system for the severity of injuries at the time of triage or later on as the patient moves along the rescue chain, and contamination status indicators.

While regular patient data charts allow for more elaborate enunciations in terms of patient history, physical examination and diagnosis, it is essential for the information to be essentialized during MCIs data documentation. One solution to maximizing efficiency and preserving detail is to take advantage of visual elements instead of plain text and optimize the chart content so that the workflow is fluent and intuitive [6, 7].

The development process of a dedicated PFC to be used during large-scale events adheres to general guidelines for this purpose. The requirements are largely accommodating and do not affect the legal quality of the document, but ensure an optimal integration of such forms into the healthcare process and set up a professional standard [8, 9]. Various initiatives developed and tested PFCs for MCIs but there is no one definite general format accepted [10].

The current research proposes an upgraded model of the PFC dedicated for large-scale events to be used by the Romanian authorities starting from a pre-established official model issued by the Romanian Department for Emergency Situations in 2015. The aim is to optimize the existing format and provide modern capabilities in terms of large-scale events management.

Materials and methods

Running a new optimized design for a PFC requires a methodic approach starting with a careful evaluation of the existing model. This mainly requires four large steps: a content analysis, a physical analysis, upgrading the design and optimization of the end product.

The Process

The first step – the content analysis – is necessary in order to identify the overall structure of the document and the elements of each section. Later on, each element is analyzed for the necessity of its presence and any required modifi-

* Correspondence to: Adrian Stănescu
E-mail: adrian@sicad.ro

cations in terms of expanding or collapsing. This may in turn give rise to supplemental elements or exclude some of them. At this point, any additional elements are taken into consideration in order to obtain a complete desired content. This may generate the need for new sections.

The second step – the physical analysis – requires listing the physical elements of the product. This depends on the necessary and desired properties and its functionality.

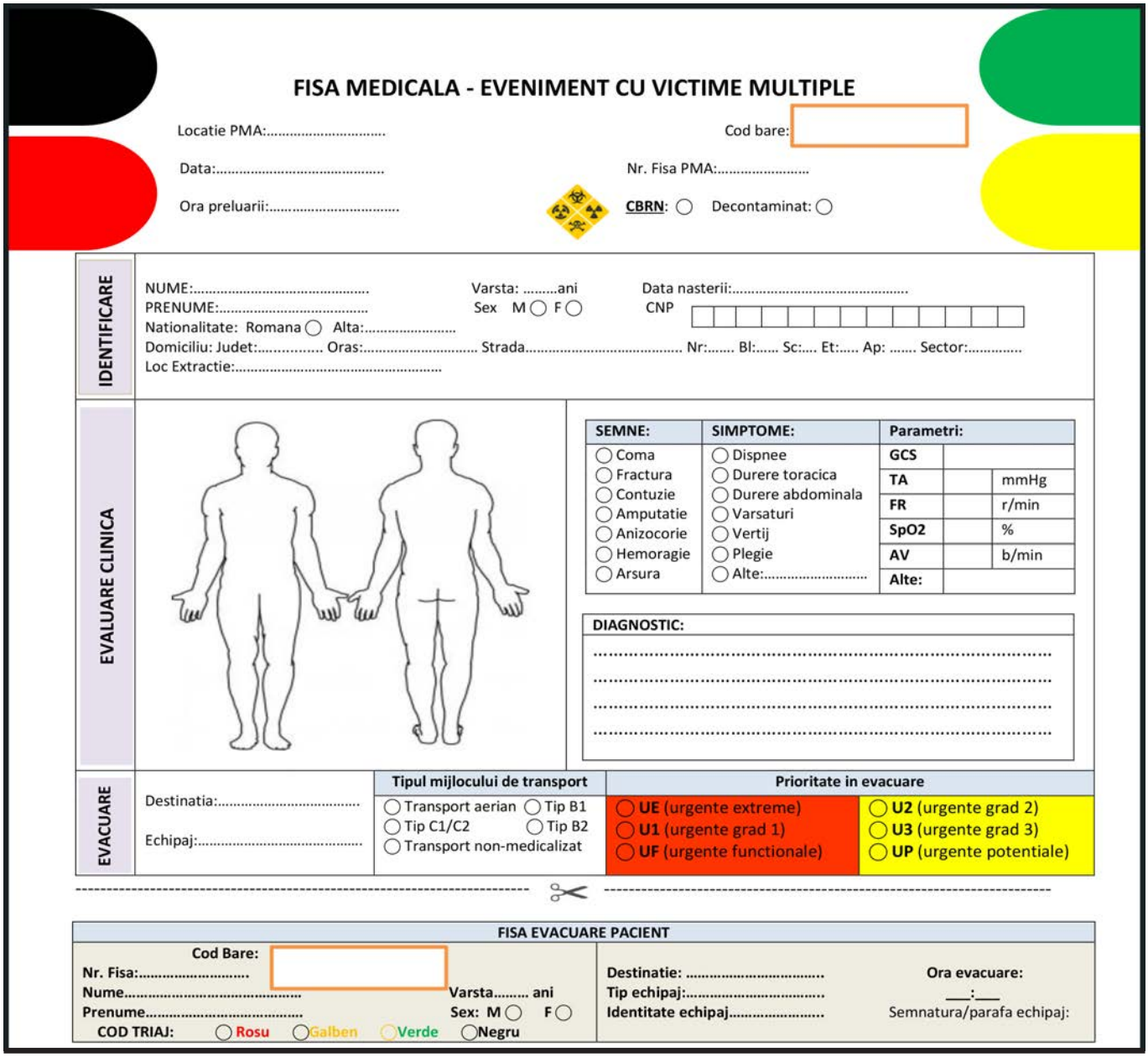
The third step – upgrading the design – is the main step of the process. It unifies the content and physical elements so that the product expresses the strategy of its use while accounting for an improved ease of use in terms of straightforwardness and fluency.

The last step – optimization of the product – is an absolute must in order to ensure the uniqueness of each section by its graphical format, a proper choice of colors and elements sizes with respect to their importance and fill-in sequence, a unitary approach of graphical properties and imagery, and maximum useful coverage with minimum dead space.

Content Analysis

The existing model is a full Letter (US) format – 8.5 x 11 inches, that is 215.9 x 279.4 mm, a canvas size with an aspect ratio and absolute values very similar to the European A4 sheet (210 x 297 mm). The design does not feature any printer margins and is a two-sided document. Since the document in use is printed on a standard A4 sheet, we are going to consider a largely accommodating printing margin of 5 mm on each side for all future documents, which makes up a surface of 574 cm² (200 x 287 mm) available for full printing on each side.

When scaling to this format, the existing model has a printed surface of 377.3 cm² (200 x 188.65 mm) on the front page and 380.24 cm² (200 x 190.12 mm) on the back page, the remainder being blank (Fig. 1)


FISA MEDICALA - EVENIMENT CU VICTIME MULTIPLE

Locatie PMA:..... Cod bare:

Data:..... Nr. Fisa PMA:.....

Ora preluarii:..... CBRN: ◯ Decontaminat: ◯

IDENTIFICARE

NUME:..... Varsta: .....ani Data nasterii:.....

PRENUME:..... Sex M ◯ F ◯ CNP

Nationalitate: Romana ◯ Alta:.....

Domiciliu: Judet:..... Oras:..... Strada..... Nr:..... Bl:..... Sc:.... Et:..... Ap: ..... Sector:.....

Loc Extractie:.....

EVALUARE CLINICA

SEMNE:	SIMPTOME:	Parametri:		
◯ Coma	◯ Dispnee	GCS		
◯ Fractura	◯ Durere toracica	TA		mmHg
◯ Contuzie	◯ Durere abdominala	FR		r/min
◯ Amputatie	◯ Varsaturi	SpO2		%
◯ Anizocorie	◯ Vertij	AV		b/min
◯ Hemoragie	◯ Plegie	Alte:		
◯ Arsura	◯ Alte:.....			

DIAGNOSTIC:

.....

.....

.....

.....

EVACUARE

Destinatia:.....

Echipaj:.....

Tipul mijlocului de transport		Prioritate in evacuare	
◯ Transport aerian	◯ Tip B1	◯ UE (urgente extreme)	◯ U2 (urgente grad 2)
◯ Tip C1/C2	◯ Tip B2	◯ U1 (urgente grad 1)	◯ U3 (urgente grad 3)
◯ Transport non-medicalizat		◯ UF (urgente functionale)	◯ UP (urgente potentiale)

FISA EVACUARE PACIENT

Cod Bare:

Nr. Fisa:.....

Nume..... Varsta..... ani

Prenume..... Sex: M ◯ F ◯

COD TRIAJ: ◯ Rosu ◯ Galben ◯ Verde ◯ Negru

Destinatie: .....

Tip echipaj:.....

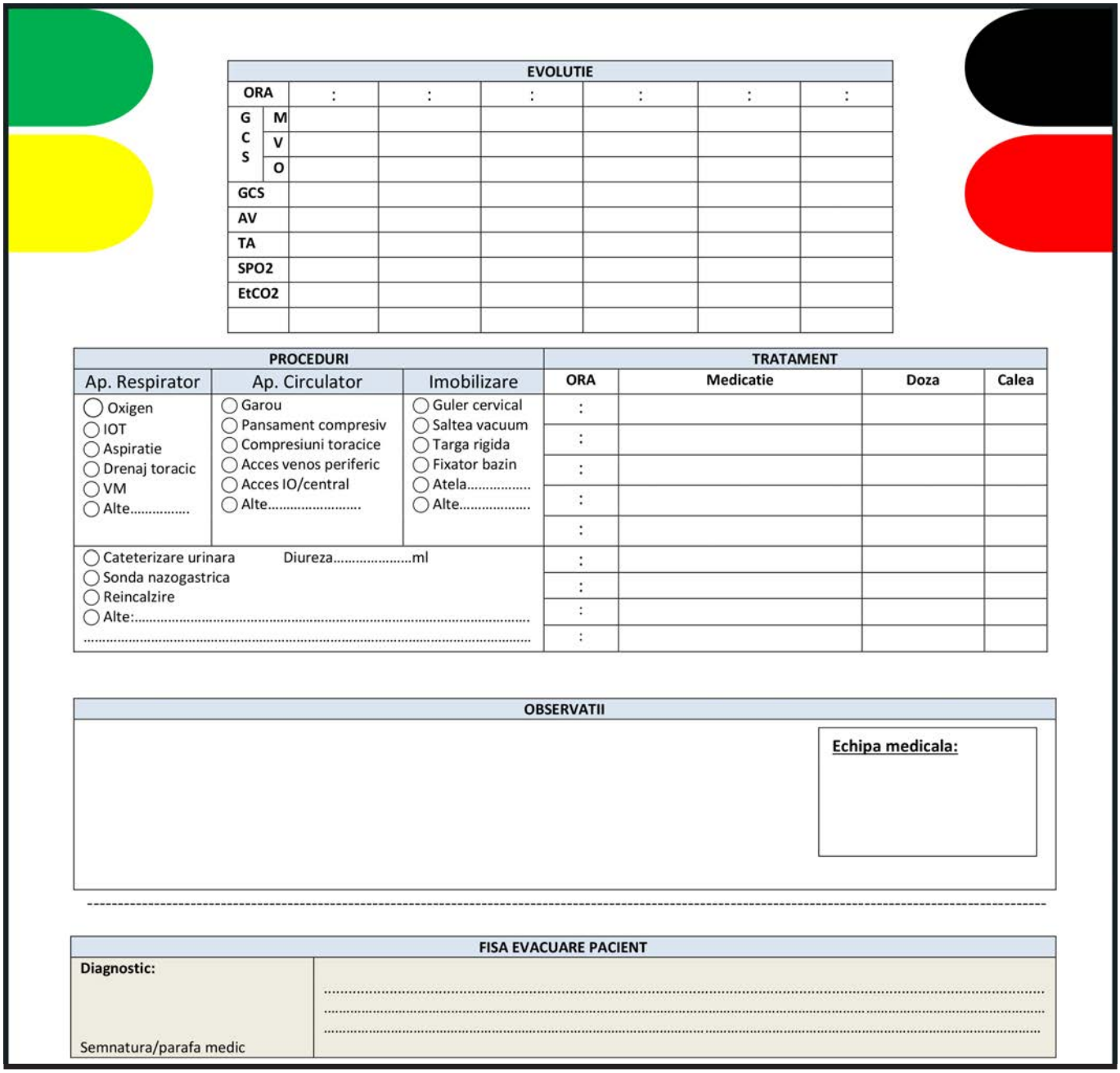
Identitate echipaj.....

Ora evacuare:

___:___

Semnatura/parafa echipaj:

Fig. 1. The front side of the official format issued by the Romanian Department for Emergency Situations in 2015



EVOLUTIE

ORA		:	:	:	:	:	:
GCS	M						
	V						
	O						
GCS							
AV							
TA							
SPO2							
EtCO2							

PROCEDURI

Ap. Respirator	Ap. Circulator	Imobilizare
◯ Oxigen ◯ IOT ◯ Aspiratie ◯ Drenaj toracic ◯ VM ◯ Alte.....	◯ Garou ◯ Pansament compresiv ◯ Compresiuni toracice ◯ Acces venos periferic ◯ Acces IO/central ◯ Alte.....	◯ Guler cervical ◯ Saltea vacuum ◯ Targa rigida ◯ Fixator bazin ◯ Atela..... ◯ Alte.....

◯ Cateterizare urinara Diureza.....ml
◯ Sonda nazogastrica
◯ Reincalzire
◯ Alte:.....
.....

TRATAMENT

ORA	Medicatie	Doza	Calea
:			
:			
:			
:			
:			
:			
:			
:			
:			

OBSERVATII

Echipa medicala:

FISA EVACUARE PACIENT

Diagnostic:	.....
	.....
	.....
Semnatura/parafa medic	

Fig. 2. The back side of the official format issued by the Romanian Department for Emergency Situations in 2015

The lower edge on each side of the document is fitted with a dotted line in order to separate the main part of the PFC from the evacuation note that is left on site at the Advanced Medical Post (AMP). Thus, the main part, that stays at all times with the patient, is printed on the front page on the upper 160.71 mm side while on the back page it is printed on the upper 162.12 mm side.

The existing official concept features a title a brief landmark area for date, time, location, contamination status and PFC ID, an area for the severity code elements (green, yellow, red and black) divided in two with a half on each upper corner, a patient identification section and 6 medical sections. The bottom part is occupied on each page by the removable evacuation note. The main part of the front page includes the title, the landmark area, the PFC ID, the severity code elements, the patient identification section and the first two medical sections i.e. Clinical Evaluation and Evacuation. The main part of the back page includes the mirrored severity code elements and the remaining 4 medical sections: Evolution, Procedures, Treatment and Observations. This last one contains an area dedicated to listing the medical team responsible for the patient.

Physical Analysis

Although the concept initially required weatherproof materials to be used in the making of PFCs, in practice it is printed on regular 80 grams plain paper. In addition, there are no self-adhesive materials used for applying a barcode label or any other sort of inclusions. Basically, the concept only requires a regular writing tool as any other medical document that can be found in a hospital setting. There

is no dedicated area for an attachment mechanism of the PFC to the patient.

Design Analysis

In terms of functionality, the design lacks dynamic triage and does not provide a patient bracelet for tracking purposes. A severity code is assigned only once – at the beginning of the rescue chain on site – by removing the finger-shaped side elements that do not correspond to the correct severity code, leaving only the proper one in place. Two barcode labels are necessary – one at the top of the PFC and the other on the evacuation note – acting as a pair, however it is not clear where do these labels come from or how and when are they generated. Removing the evacuation note is simply done by folding it and ripping it off. The PFC is designed to accompany the patient at all times, whereas the evacuation note is left at the evacuation point of the Advanced Medical Post.

Concept Upgrade

Upgrading the current concept revolved around three targets: enabling dynamic triage, increasing and improving visibility of all areas and the overall usage of the PFC, and bringing the concept up to speed with current and future electronic management solutions for mass casualty incidents.

Enabling dynamic triage involves the use of mobile elements. Each mobile element must possess its own severity code that can be highlighted at any given time depending of the severity status of the victim, and most importantly – it must be visible from a distance. In addition, changing the severity code has to be allowed any number of times and in any required sequence, including reverting to a previous code. The mechanism must allow a rapid change in severity status while minimizing the risk of accidental changes or element detachment.

Increasing and improving visibility of all areas impacts on the product form factor and modifying the general structure so that any available previously unused space is reconfigured so that the active surface covers as much of the printed space as possible while also increasing the visibility of text and figures and maximizing fill-in areas. Any free space that cannot be used as an active surface may be used for brief and clear instructions for the personnel using the PFC. Applying a proper color strategy by separating adjacent sections using different colors and assigning adequate color intensities to the different regions of the PFC in respect to their importance and sequence of use is part of the visual optimization process. Dedicated areas for contamination status and visual and electronic coding are assigned to the identification section.

Integrating the upgraded concept within electronic management solutions implies embedding of wireless (NFC/RFID) tags as well as visual codes that may be typed or scanned by cameras or industry scanners. Simplifying the unique identification of each PFC requires redundant strategies while ensuring there are no multiple identifiers for a given PFC.

Using a patient bracelet for ensuring patient identification and tracking at all times requires a largely simplified structure with written identification elements and any other essential information, as well as visual codes with or without wireless tags. The functionality of the bracelet is in complementary use with the PFC.

Upgrading the material list is essential since the selection must account for mobile elements, detachable labels and embedded tags as well as the use of the product under varying environment conditions.

The upgrading process starts with establishing the new design and its functionalities, continues with redefining the overall structure and the included content and ends with a careful and exhaustive optimization process.

Evaluation

The component sections of both models are precisely measured using professional software – CorelDraw X8 (version 18.1.0.661, Corel Corporation, 2016). Measurements are reported as square centimeters and values are rounded to two decimals. Differences are noted and the content is analyzed. Statistical analysis is carried out by applying chi-square tests using STATA/MP 14.1 (StataCorp LLC). Statistical significance threshold was set to a p-value of 0.05 for a confidence interval of 95%.

Results

Concept Upgrade

The upgraded concept contains the PFC and the patient bracelet as separate but complementary items. Each pair is linked by unique alphabetical codes, visual QR codes and wireless NFC/RFID tags, all with a unified correspondence.

The main distinctive features of the PFC are dynamic triage, unique code identification, QR visual codes, wireless tags, irreversible clear contamination status highlighting and the AMP entry point note (Fig. 3, 4).

Design Analysis

Dynamic triage works by flipping color-coded magnet fastening evacuation notes from the front side to the back side of the tag and vice versa and (un)covering the corresponding triage color on both sides. There are four AMP evacuation notes available – one for each severity code, and a similar sized AMP entry point note – all located on the front left hand side of the PFC. All five notes are detachable and are used in order to keep patient records at the entry and exit points of the AMP. The top note is removed at the triage (entry) point and only one of the four evacuation notes – the one with the current severity code – is removed at the exit point.

Each PFC and patient bracelet pair (Fig. 5) is assigned a unique 4-character ID code. This makes up a total of 439400 unique IDs. There is a total of 9 copies of the

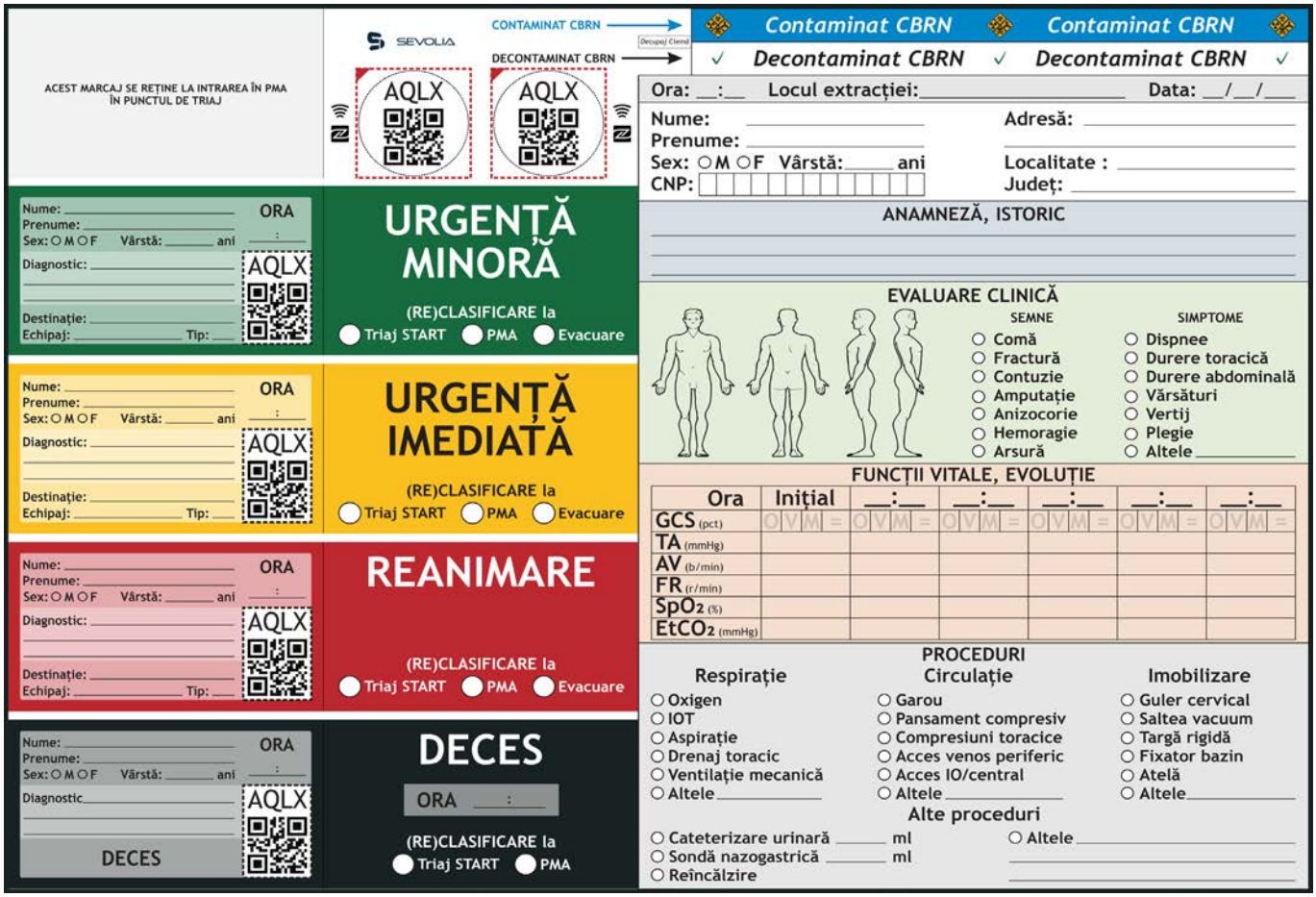


Fig. 3. The front side of the upgraded model (design)

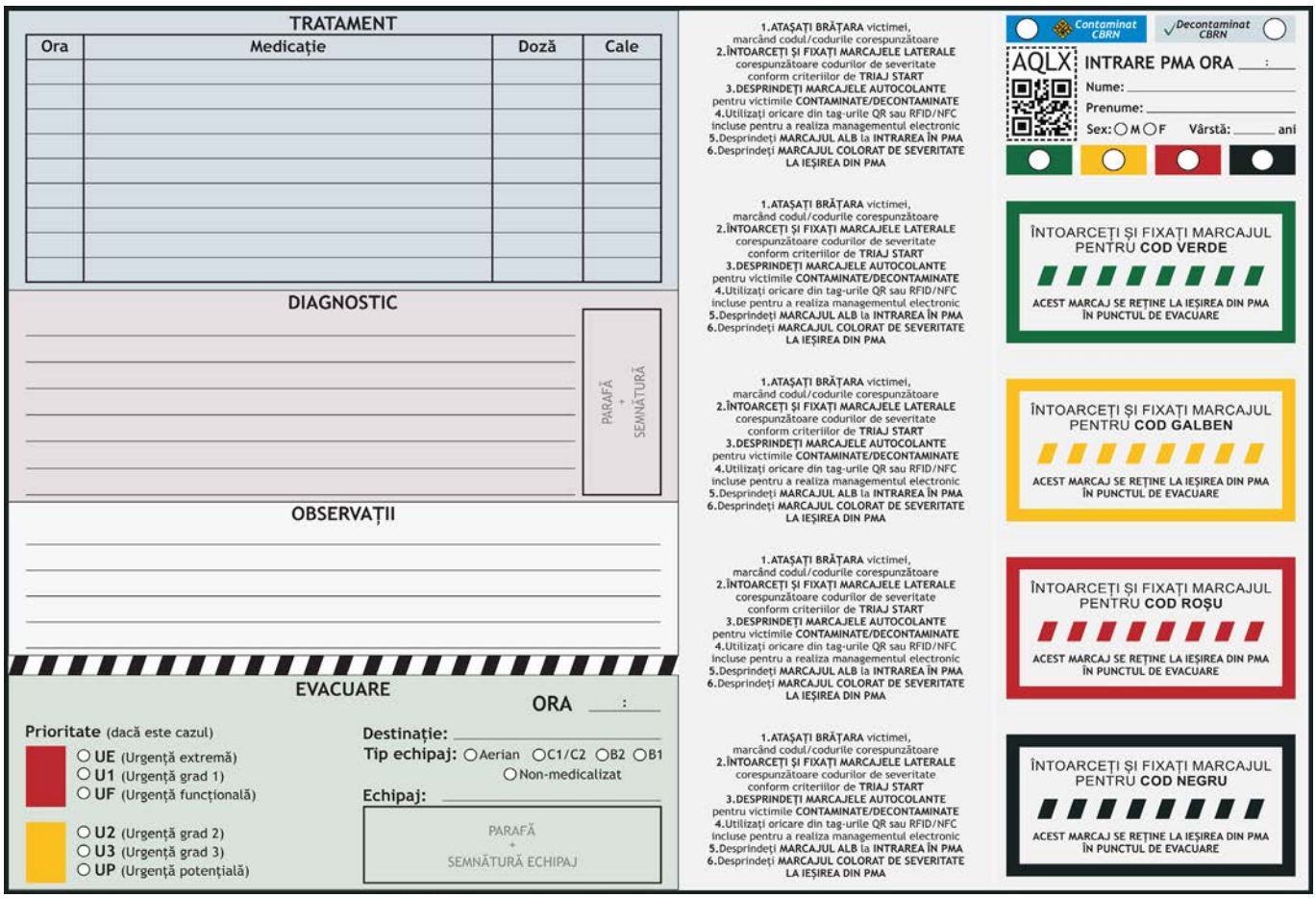


Fig. 4. The back side of the upgraded model (design)

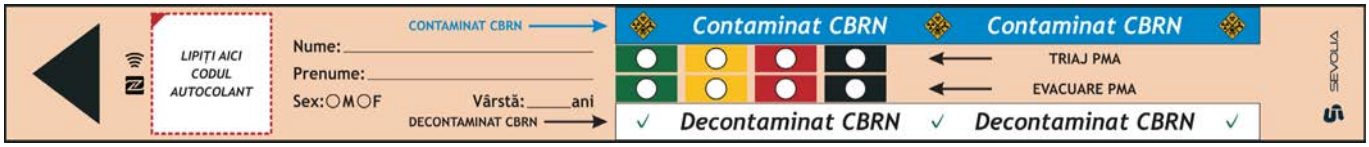


Fig. 5. The patient bracelet paired with the upgraded model (design)

assigned code and all of them are initially located on the PFC. Two of them can be found on larger self-adhesive labels at the upper left corner on the front side of the PFC. This allows for any bracelet to be linked to any new PFC. One of these two can be removed and then stuck on the corresponding space at the left edge of the patient bracelet. The remaining one is for applying the label onto hospital documents. The area remaining beneath the self-adhesive labels is printed as well containing the same copies.

There are two markings for the contamination status, "CBRN contaminated" and "CBRN decontaminated", which may be rendered visible by peeling off the corresponding coverings at the front top edge of the PFC. The same functionality is applied to the corresponding patient bracelet.

When in use, the front and back sides of the PFC are a mixing of the front and back sides of the designed model, lacking removed elements at different times of the rescue chain. The patient bracelet will also have its ID label applied. A proper example of the PFC and patient bracelet for an uncontaminated patient at the time of secondary triage is depicted below (Fig. 6, 7, 8).

The PFC may be tied to the patient using a cord or any other binding mechanism passed through the clamp clipping at the center top.

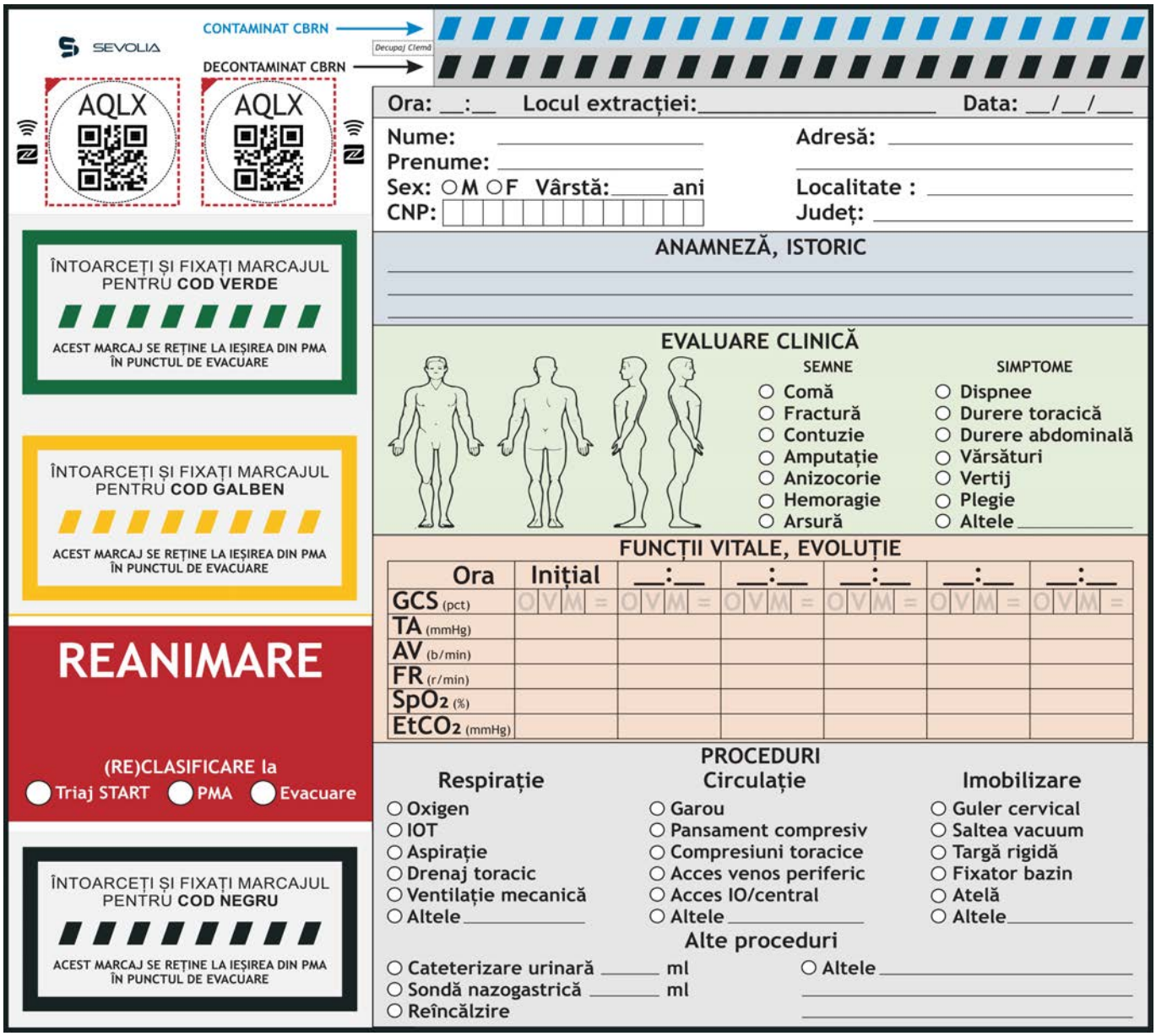


Fig. 6. The front side of the upgraded model (in use)

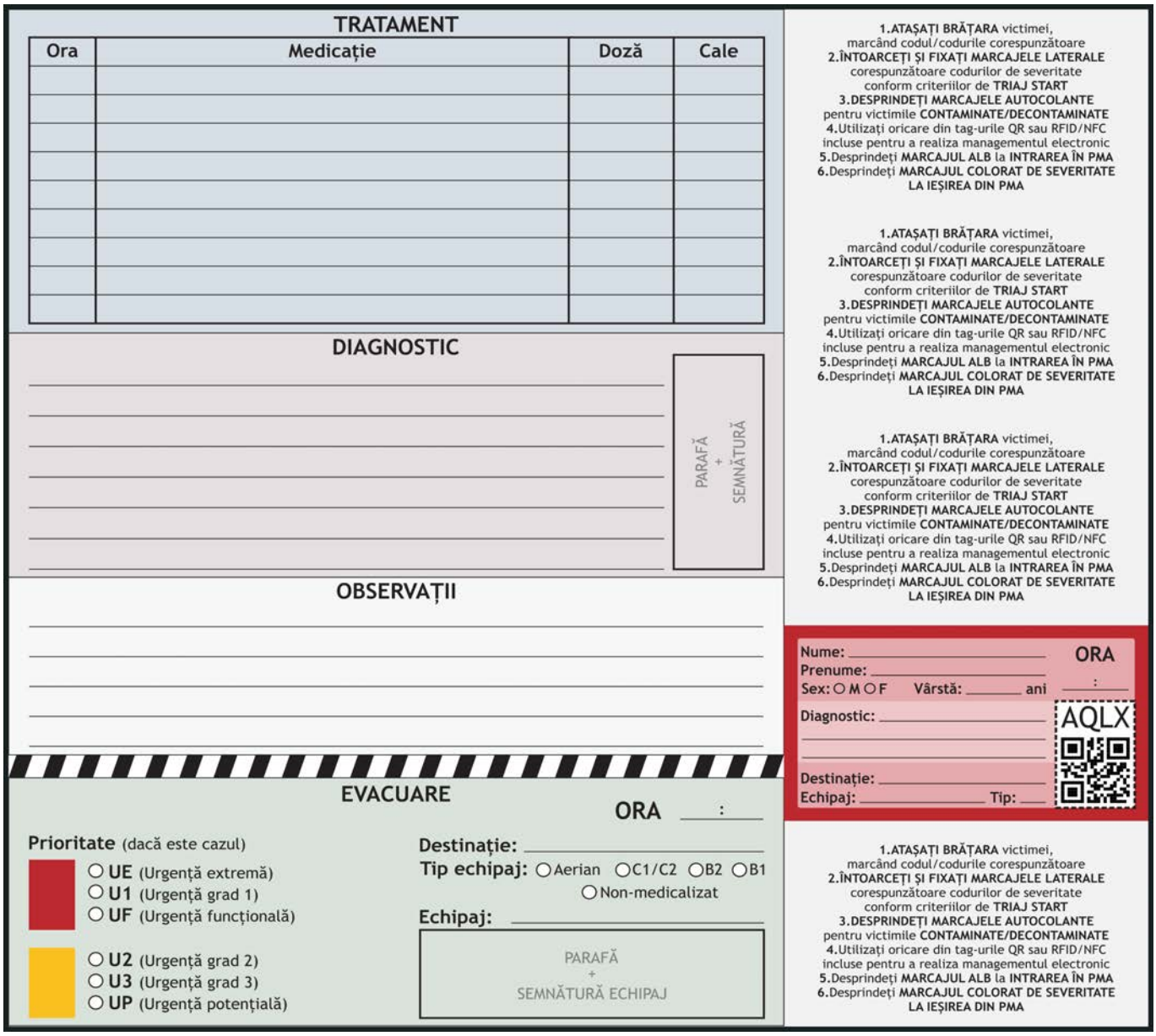


Fig. 7. The back side of the upgraded model (in use)

Removing the proper labels at the entry and exit point of the AMP respectively allows for independent patient inventories at these locations. The entry label contains the patient's name, sex, age, initial severity classification and contamination status as well as the 4-character ID and its corresponding QR code. The exit label has a colored background according to the severity code at the moment of the evacuation from the AMP, containing the patient's name, sex, age, destination, pickup crew identification and type, diagnosis and the 4-character ID and its corresponding QR code. Sample entry (Fig. 9) and exit labels (Fig. 10) for an uncontaminated patient classified initially as a yellow code, later on classified as a red code, is being depicted below.

Wireless compatibility with electronic management systems is accomplished by embedding NFC tags under the upper two removable copies of the patient ID on the PFC and under the printed PVC sheet of the back of the PFC on the position of the second upper removable copy of the patient ID. This way, when transferring the upper first removable copy from the PFC to the bracelet, the NFC tag is transferred as well thus providing wireless management capabilities to the bracelet itself. The same is true for the second copy in order to be transferred onto the hospital

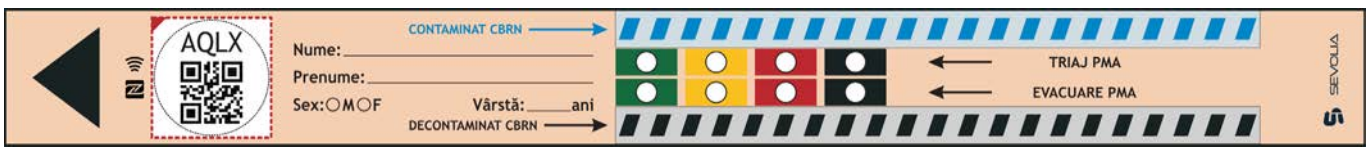


Fig. 8. The patient bracelet paired with the upgraded model (in use)

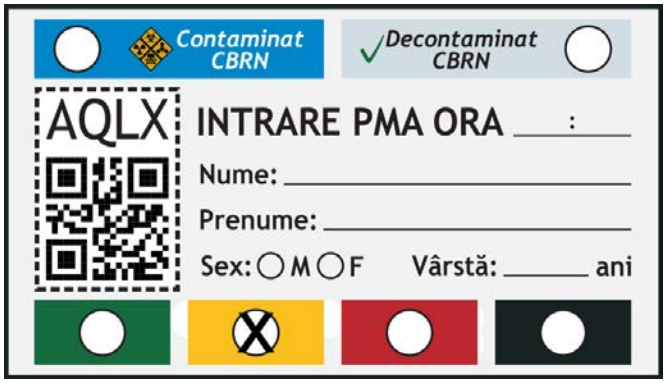


Fig. 9. The removable AMP entry point label (in use)

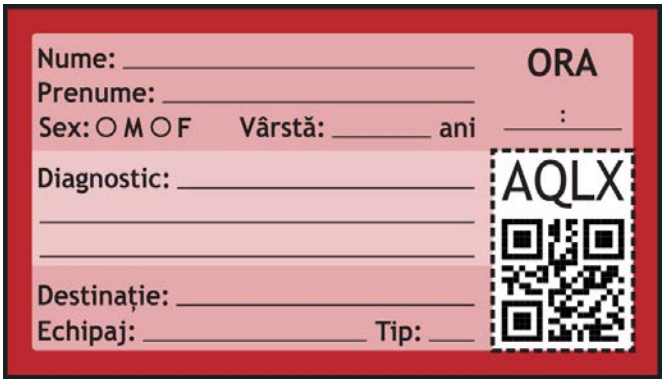


Fig. 10. The removable AMP exit point label (in use)

patient chart. Similar NFC tags may be also applied under each of the 5 copies of the patient ID on the removable tags in order to extend the wireless functionality at the entry and exit points of the AMP, using the corresponding removable labels as carriers for the tags. All NFC tags are pre-written electronically so that they will express the same ID as shown by the 4 characters and also encoded by the QR tag.

The format of the encoded information for both the NFC tags and QR tags contains proprietary validation strings and a specific data format in order to limit their use for the designed purpose and restrict any unauthorized access.

The integration of all available elements for enabling the electronic management using the PFC and patient bracelet is depicted below (Fig. 11, 12, 13).

Physical Analysis

The PFC is fabricated using a 2 mm thick 214x200 mm free-foam PVC sheet fitted with 4 10x1 mm N52 Neodymium disc magnets for locking the last 4 removable elements. A color laser printed plasticized self-adhesive 282.5x200 mm (565 cm^2) paper sheet wraps the PVC sheet and envelops 5 25x10 mm 0.5 mm thin steel plates for the removable elements.

The patient bracelet is made out of the same color laser printed plasticized self-adhesive 282.5 x27.7 mm paper sheet. The back of the left end can also be peeled off in order to provide a locking mechanism over the victim's arm or leg.

The 4-character IDs together with the corresponding QR codes are printed separately on the same laser printed material and are superimposed with the NFC tags over the designated spaces.

Content Analysis

Besides using a different strategy for selecting the severity code and contamination status there is a number of changes to the different sections of the PFC. The main differences are highlighted by layout, spatial dimensions including surface and content.

The severity code selection element on the official model is a shape formed by a half ellipse and a rectangle adding up to an area of 7.80 cm^2. There are 4 such elements on the front side and another 4 on the back side, totaling an area of 62.37 cm^2. The upgraded model uses rectangular elements of 26.32 cm^2, 4 on the front side plus another 4 on the back side, while another 4 identical areas act as severity code indicators but are used as evacuation tags. This totals 210.58 cm^2, without the entry point tag which has the same area of 26.32 cm^2. Thus, there is an increase of dedicated area of 237.62% between the upgraded model and the official model without considering the triage entry element.

Contamination status is marked over the front side on an area of 5.38 cm^2 on the official model whereas on the upgraded model the corresponding area is 26.90 cm^2, a 400.44% increase.

Patient identification by assigning character identifiers and visual elements is achieved by using 1D barcodes and numerical characters on the official model whereas these are replaced by 2D QR codes and alphabetical characters on the upgraded model. The official model has 2 such elements covering an area of 2.28 cm^2 each, while the upgraded model has 5 elements covering 2.46 cm^2 each and another 2 covering 6.16 cm^2 each. The AMP chart number of 0.62 cm^2 on the official model has been removed and no such element appears on the upgraded model. This totals 5.17 cm^2 on the official model and 24.62 cm^2 on the upgraded model, making up an increase of 376.21%.

The space and time event coordinates are split into two sections on the official model, the main coordinates being located at the top of the front side while the extraction place is located next to the legal data for patient identification. The upgraded model lacks the AMP location and all other elements are grouped together in a dedicated section. There is a total dedicated area of 7.45 cm^2 on the official model and 8.89 cm^2 on the upgraded model, which is a 19.31% increase.

Legal data for patient identification has a dedicated section on the official model covering an area of 48.41 cm^2, but only 24.99 cm2 of that – 51.63% – is being put to use for this purpose, whereas the upgraded model has a 32.64 cm^2 section, with a 30.61% increase in active space. The home address format is condensed so that it is easier to fill it in by allowing free flow input in this regard given the

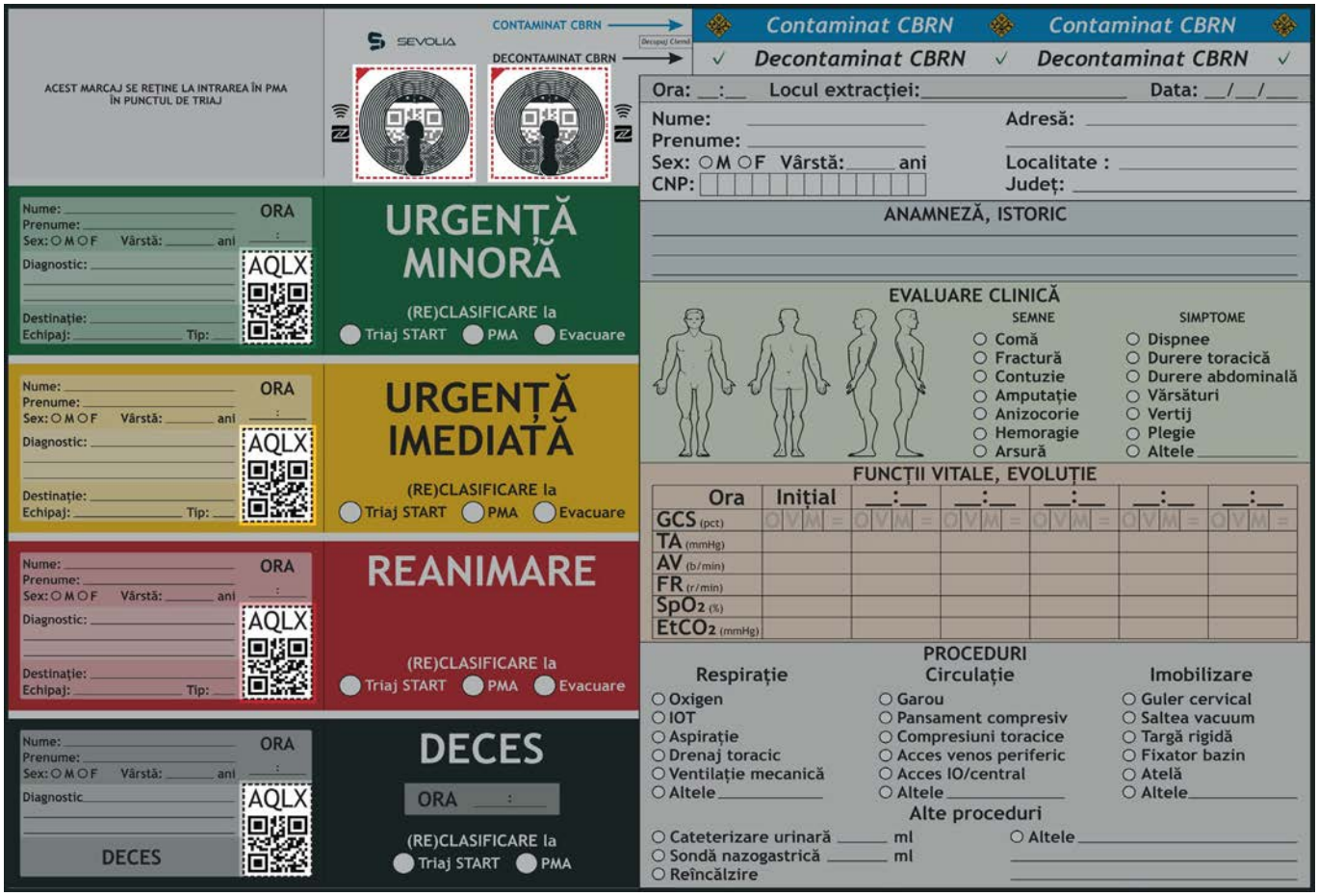


Fig. 11. Electronic management elements locations on the front side of the upgraded model

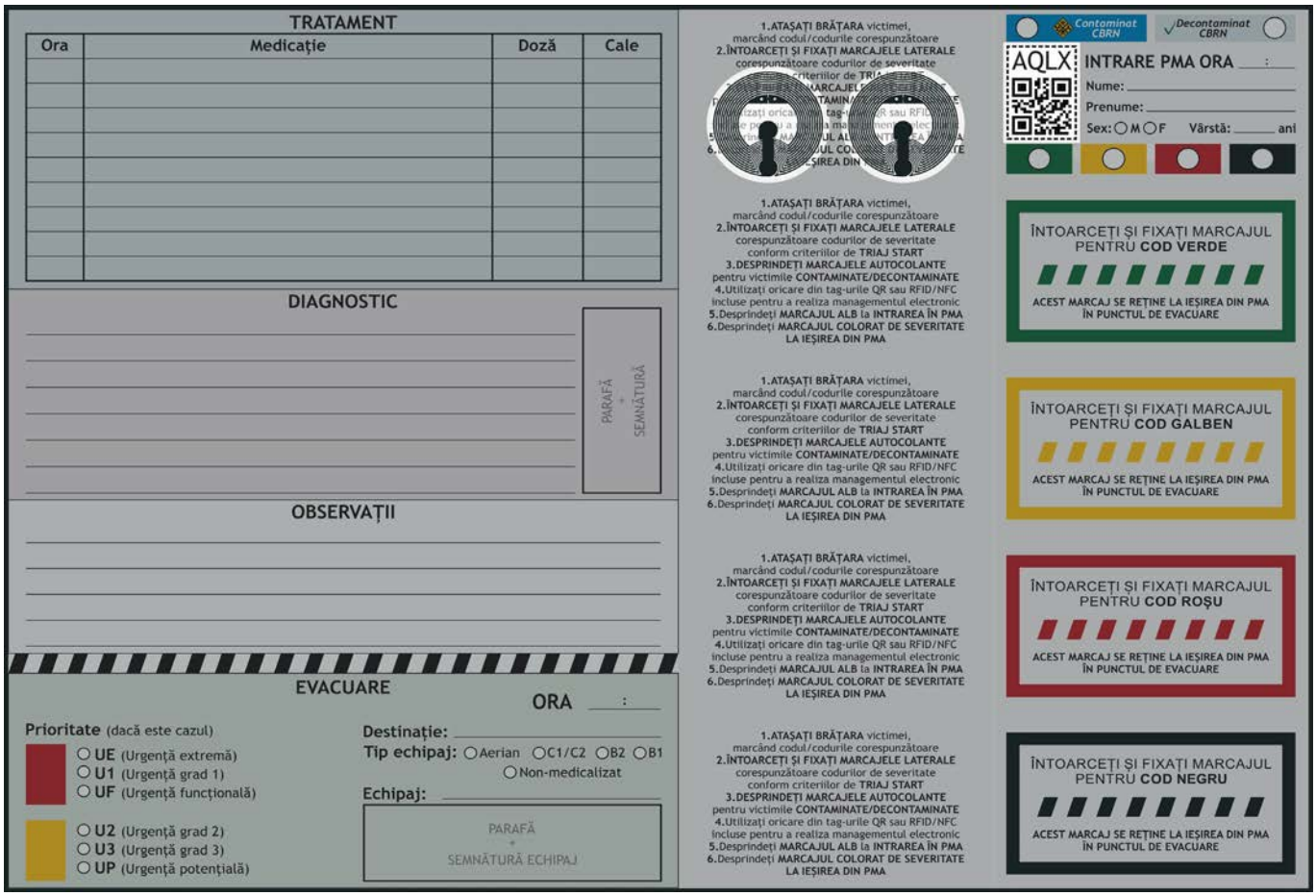


Fig. 12. Electronic management elements locations on the back side of the upgraded model

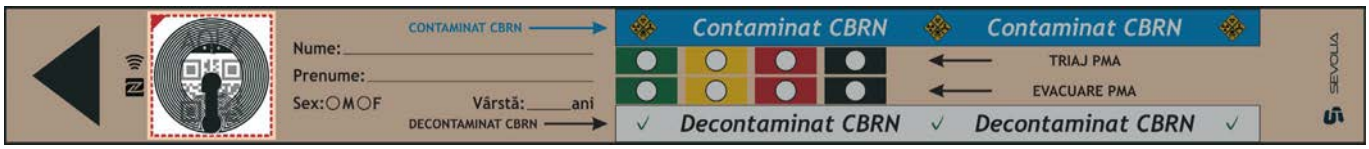


Fig. 13. Electronic management elements locations on the patient bracelet paired with the upgraded model

heterogeneity of text strings to be used while maintaining a restricted total space.

There is an exclusive patient history and event circumstances section on the upgraded model that covers an area of 26.76 cm^2.

The clinical evaluation section has two modules for each PFC model, and the diagnosis section and initial vital parameters are being added to this section as well on the official model. The first module is a schematic representation of the human silhouette and the second one contains a listing of signs and symptoms. The first module with the front and back human silhouette covers 38.10 cm^2 out of the dedicated 58.55 cm^2 area – 65.08% – on the official model, while the human silhouette is depicted with the front, back, left and right sides on the upgraded model covering 19.99 cm^2 out of the dedicated 36.91 cm^2 – 54.15%. This outputs a total decrease of 47.54% for the overall surface of the first module. The second module covers 16.55 cm^2 on the official model and 23.04 cm^2 on the upgraded model, thus increasing the dedicated area with 39.21%.

Vital signs are split into two sections on the official model, only the initial parameters being left on the front side covering 10.95 cm^2, while their evolution constitutes a separate section on the back side. The ladder covers 59.65 cm^2 out of which 5.53 cm^2 are left for an unknown parameter. The upgraded model has a single unified section of 59.34 cm^2 on the front side. Thus, there is a slight 15.96% decrease in the total area between the upgraded and the official model.

Procedures being performed cover 46.71 cm^2 on the official model but 81.40 cm^2 on the upgraded model – that is 74.26% more dedicated area. Likewise, the treatment section covers 49.93 cm^2 on the official model and 92.65 cm^2 on the upgraded model, increasing the dedicated area with 85.57%.

The diagnosis section is listed on the front side on the official model inside the clinical evaluation section and it covers an area of 23.33 cm^2. The upgraded model contains this section on the back side and includes an area for the physician's imprint and signature. The active space is 62.74 cm^2, making up an increase of 168.92%.

The area available for making observations appears as a dedicated section on the back side of the official model, also containing a separate area for listing the medical team. Active space covers 52.21 cm^2. The corresponding section, without any additions, is present on the back side of the upgraded model and covers 50.87 cm^2, which is a slight downward difference of 2.55% for the upgraded model.

The official model contains the section for listing the medical team, which covers 9.19 cm^2, but it is not adapted to an imprint shape. The upgraded model contains only a section for the physician's imprint and signature adapted to the shape of the imprint, covering 7.10 cm^2, thus decreasing the dedicated surface with 22.76%.

The evacuation section on the PFC is included on the front side of the official model and covers a total area of 32.61 cm^2. It does not incorporate any adapted area for the mobile crew's imprint and/or signature. On the upgraded model, the evacuation section is included at the bottom of the back side, clearly separated from the upper portion by a patterned separator, covering 66.46 cm^2, which is 103.78% more dedicated space than on the official model. It also includes an adapted area for the mobile crew's imprint and/or signature.

The last exclusive section containing instructions (5 identical groups) for using the PFC and patient bracelet covers 136.84 cm^2 of the back side on the upgraded model.

The evacuation note to be removed from the PFC covers 32.46 cm^2 on the front side of the official model, out of which 2.35 cm^2 are dedicated to a barcode label, and 32.48 cm^2 more on the back side, thus totaling an active area of 62.59 cm^2. The upgraded model has 4 notes available for removal differing by the background color representing the severity code at the moment of the evacuation from the AMP. Each of them covers 23.25 cm^2 of active space (an extra area of 3.11 cm^2 is dedicated to the identification visual elements) and is printed only on one side – the back side is pre-filled with instructions on how to operate the dynamic triage mechanism. For a single evacuation note there is a decrease in dedicated area of 62.85%. However, the overall area available for all 4 evacuation notes is 93.00 cm^2, upscaling the dedicated area with 48.58% in the favor of the upgraded model. Also, the upgraded model evacuation notes do not mention the initial code of severity. This is available together with the patient's identification data and contamination status on the entry point note which covers the same area of 23.25 cm^2 plus 3.11 cm^2 for the visual identification elements.

The total active surface on the official model is 507.20 cm^2, while the printed area including inert space is 551.06 cm^2. This leaves 7.96% of the actual printed area for inner dead space. The printed area with exterior dead space is 757.54 cm^2. The overall area available for printing by canvas design is 1148 cm^2. The official model does not contain any sections for instructions, the inert and dead space being identical. Thus, the total dead space by design on the official model is 55.82%.

The total active surface on the upgraded model is 914.80 cm^2, while the printed area including inert space is 1068.56 cm^2, leaving 14.39% of the actual printed area

for inert space. Since 139.51 cm^2 are used for instructions, inner dead space covers 1.33% of the actual printed area. The printed area with exterior dead space is 1130.31 cm^2, with an external dead space of 5.43%. The total dead space by design on the upgraded model is 6.72%.

The active surface increased 80.36% from 507.20 cm^2 on the official model to 914.80 cm^2 on the upgraded model ($p<0.0001$). Instructions are printed on 139.51 cm^2 only on the official model. Inner dead space dropped 67.51% from 43.86 cm^2 on the official model to 14.25 cm^2 on the upgraded model ($p=0.0002$). Outer dead space dropped 88.97% from 689.18 cm^2 on the official model to 76.00 cm^2 on the upgraded model ($p<0.0001$). The patient bracelet is not included for these computations. The physical total format of the PFC as a physical object remained unchanged – the A4 sheet.

The Patient Bracelet

The patient bracelet is made out of the same plasticized printed material as the PFC but does not include the free-foam PVC core. It has the same total length as the PFC and it is 27.7 mm wide. It is secured against the patient's arm or leg by peeling off the self adhesive left back end – marked on the front by a black arrow – and fitting that end on the opposite one.

It is designed with a dedicated area to fit the detached bundle of NFC tag and QR code together with the 4-characted ID at the left end. It accounts for patient identification data (name, sex, age), contamination status and severity code. The contamination status is set by the same peel-off mechanism, and two severity codes can be marked – at the entry and exit point of the AMP.

Discussions

The upgrade process results in almost doubling the available active area without the need to change the document size format of the product. Even more so, inner and outer dead spaces are greatly reduced while instructions are added.

Unnecessary elements like AMP chart number and the unspecified vital sign line have been removed, other elements like the expanded address format and medical team complement have been modified. Adjustments were made in unifying previously split sections like vital signs and their evolution, and displacing sections like diagnosis and evacuation in order to maintain a more laminar flow of operation.

Ten sections significantly have enlarged their designated active area while keeping the same content. Extra sections are added, like patient and event history as well as specific instructions for the user.

Visibility is greatly improved by using larger fonts given the extra reach of active space on most sections and by adding shades of different colors to highlight different sections.

Dynamic triage is made available by using side flipping elements that can be detached and later on used for inventory at the entry and exit points of the AMP. Electronic management is enabled by implementing wireless NFC tags, replacing 1D barcodes with 2D redundant QR codes and assigning 4-character ID codes to allow 439400 different combinations. This amount can be largely augmented by switching from Latin alphabet restricted characters to alphanumeric characters, thus expanding the scale to 1632960 different combinations while keeping the 4-character ID format. The previous range of possible combinations when using the 1D barcode is unknown.

Electronic data security features are in place by using proprietary format strings and data formats to restrict access to and from the electronic management elements.

The user benefits from solid weatherproof and weather resistant materials in an easy to handle format, allowing the product to be easily attached to the patient or different nearby objects and easily removed in order to continue the flow of operation.

The patient bracelet allows for an easy marking of the corresponding patient, preserving only the most important features for this purpose i.e. identification elements including the ones for electronic management, contamination status, and AMP entry and exit points severity codes.

Conclusions

The upgraded model offers a variety of improvements for both the overall rescue effort as well as the end user of the product. It allows for previously unavailable features like unlimited dynamic triage and enables the use of electronic management solutions.

Pre-printed identification codes make it very easy to safely operate a very large number of products and seamlessly identify them by visual or electronic means, without the need to dedicate time and effort for these actions, thus decreasing the chance for error.

The text strings of the content can be easily modified to accommodate internationalization.

The downside of the end product is its significantly higher cost in comparison to a regular A4 paper sheet. However, if the official model is printed on weatherproof and weather resistant materials, the corresponding costs get in a significantly closer range. Agencies may also decide on wireless technology and the number of wireless tags to be used – or by not including any at all –, largely adjusting the total cost in both directions. Some of the costs may be lowered by recycling the neutral composing elements like the free-foam PVC sheet, magnetic and metallic elements, but this may set the need for a recycling service that would have a cost of its own.

The variety of options and features makes the product fit for adoption at different scales, either local, regional, national or even international. Its implementation requires training and a learning curve.

Given the fact that the Romanian official model came into play relatively recent and its adoption is not of the clearest, it is hard to imagine that switching to any up-

graded model would be feasible despite of the numerous advantages.

However, carrying out usability studies using professionals to validate the proposed concept is desirable and may open the door for a future adoption as well as performing adjustments and optimizing the product for the version.

Conflict of interest

None to declare

Authors' contribution

AS – Conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, software, visualization, writing original draft
SMC – Data curation, supervision, validation
CMB – Data curation, supervision, validation

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