Simulating a multi-level priority triage system for Maternity Emergency

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ABSTRACT

Nowadays Decision Support Systems are increasingly used in order to help health professionals. An example of this application is the implementation of a triage system in hospital emergency. These systems allow more effective and rapid decisions taking into account the clinical needs of patients. In *Centro Materno Infantil do Norte* it was implemented an intelligent system of pre-triage which aims to prioritize the patients on two levels: Urgent (URG) and (ARGO). However, although specific for obstetrics and gynecology cases, the system does not meet all clinical requirements. Thus using a simulation algorithm developed within this framework, it was intended to simulate a specific priority triage system for gynecology and obstetrics but with five levels of acuity as suggested by the Portuguese general department of Health (Direção Geral de Saúde). For this study the repository of specific pre-triage system was used to test the algorithm. After application, it was found that the implementation of this system in *Centro Materno Infantil do Norte* will reduce waiting time, allowing a uniform distribution according to the waiting time and the clinical features. The percentage of deviation between the waiting time and the actual time obtained by simulation algorithm is approximately 121.6%

INTRODUCTION

Emergency services in hospitals of the National Health System (NHS) are popular for several reasons. Sometimes the situations are not really emerging as users / patients are accustomed to use health services easier and more effectively. This large influx of patients to emergency services of several severity, requires the use of a triage system in a general emergency room. There are many intelligent systems to assist the triage process at hospital emergency room, such as the Manchester Triage System (MTS) or the Canadian Triage and Acuity Scale (CTAS), however these triage systems are more general in nature and they are not suitable for specific situations (Cabral et al. 2013). In the case of Gynecology and Obstetrics specialities at Centro Hospitalar do Porto (CHP), it was previously used the MTS system.. In 2010, based on the MTS system, a specific pre-triage was implemented for gynecology and obstetrics. This system only distinguishes patients from two levels: emergency (URG) or outpatient service (ARGO). Based on this requirement, there were developed six flowcharts based in a specific questionnaire for each class of patients to help the pre-triage of patients at the Júlio Dinis Maternity Hospital (MJD). This system was originally installed in MJD at an early stage and is now also integrated into Centro Materno Infantil do Norte (CMIN) recently created.

However this system of pre-triage only solves part of the explicit problems of obstetrics and gynecology, because it only divides the severity of patients in two levels of priorities and not in five priority levels as it is required by the DGS ("Triagem Obstétrica- modelo de Triagem," 2013). Furthermore, simulation techniques can simulate the real system in a virtual environment. This simulation is often possible through the use of standardized techniques of simulation or alert the development of specific mathematical or logical models molded to the problem. (Sagar et al. 1994) (Tanabe et al. 2004) (Ullrich & Kuhlen, 2012). In this sense, it becomes possible to simulate a specific system of priorities for gynecology and obstetrics with five acuity levels (Cabral et al., 2011).

This article covers the development of a simulation algorithm of an intelligent system for triage of specific priorities for gynaecologists and obstetrics with five priority levels, using the historical clinical repository for pre-triage system used during the past 4 years of existence. This work has as main objective of understanding if the simulated intelligent system really bring advantages over the existing (pre-triage) system. This work allows to assess the quality and study of the viability of adopting a priority triage system to a specific domain such as maternity care.

This article includes six sections. In the first section it was described the state of the art and the work performed; the second section shows the system to be validated and the requirements; in the third section it is presented the validation algorithm; in sections 4 and 5 the results and discussion are presented; and finally the conclusions are presented and future work is suggested.

BACKGROUND AND RELATED WORK

Description of the existing system in CHP (pre-triage system and MTS)

The Centro Materno Infantil do Norte (CMIN) is integrated into the Centre Hospitalar of Porto (CHP) along with the Hospital de Santo António (HSA) and Hospital Joaquim Urbano (HJU). Before founding the CHP in 2007 they were three separate entities. Women who need emergency care could make use of the HSA emergency, where patients of gynecology were triaged according to the MTS. The Manchester Triage Group was established in 1994, aiming to establish a consensus among doctors and nurses, regarding the rules for conducting screening (Mackway-Jones et al. 2006) (Maconochie & Dawood, 2008). The MTS was introduced in the UK in 1996 and began to be implemented in the United States in 2000. Currently it was already spread to several countries in Europe. This is a system consisting of 52 flowcharts for triaged patients in general way.

Due to the general nature, MTS does not meet specific conditions for obstetrics and gynecology. Therefore it has been developed a specific pre-triage intelligent system for gynecology and obstetrics. It prioritizes patients on two levels: Emergent (URG) in urgent cases or outpatient services (ARGO) for non-emergency cases. The development of this system was inspired by the MTS system and the knowledge obtained directly from the empirical and scientific knowledge of health professionals. This combination was used to make the first version of the decision models. This system is also capable of triage six classes of patients: pregnant women; postpartum; non-puerperal women; pregnant women; patients to Voluntary Interruption of Pregnancy (VIP); and patients for examination of Cardiotocography (CTG). It is therefore characterized by a specific flowchart for each class of patients.

Since 2010, MJD / CMIN served nearly 66,730 patients: 18,773 in 2010, 18,348 in 2011, 12,445 patients in 2012 and 17,929 in 2013. The system distinguishes only between URG and ARGO, and the nurse can force ARGO or URG anytime, if he/she disagrees with the decision of the system or choose EMERG if it is a very serious situation.

The distribution of classes: URGO and ARGO is presented in the Table 1 and in figure 1.

Only patients who had a total time of triage between 0 and 220 were included. This filter is applied because a large percentage of patients who are triaged are not admitted. There are also situations in which the patient's situation is so emergent that patients are triaged after being admitted. In this case, the time after the triage is negative, and then these records were also cleaned.

In the table 1 it is used the following acronyms: ARGO pregnant woman (Argo –pw), URG pregnant woman (URG (Pw), ARGO postpartum woman (ARGO –ppw), URG postpartum woman (URG –ppw), ARGO non-postpartum woman (ARGO –nppw), URG non-postpartum woman (URG –nppw), ARGO maybe pregnant (ARGO mp), URG maybe pregnant (URG mp), ARGO to VIP (ARGO v), URG to VIP (URG v), ARGO to CTG (ARGO c), URG to CTG (URG c)

Table 1- Number of patients triaged at the pre-triage system and its minimum waiting time, maximum waiting time and average waiting time divided by types of patients and pre-triage result.

Designation	**Number of Patients**	**Minimum waiting time**	**Maximum waiting time**	**Average waiting time**
ARGO pw	11473	0	219	7.04
URG pw	19226	0	211	6.75
ARGO ppw	1351	0	170	6.88
URG ppw	1958	0	240	6.45
ARGO-nppw	13373	0	232	7.02
URG nppw	6441	0	237	7.12
ARGO mp	3029	0	240	7.59
URG mp	983	0	198	6.62
ARGO v	2352	0	240	7.85
URG v	68	0	204	8.38
ARGO c	1840	0	227	6.72
URG c	479	0	106	5.53

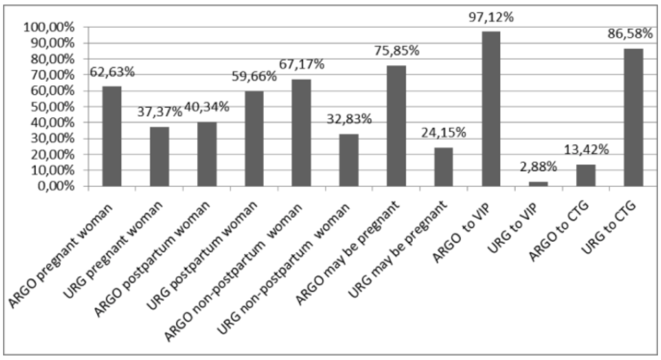


Figure 1 **-** Percentage of patients triage in MJD distributed by flowcharts / patient types and the pre-triage system result**.**

As already mentioned there is only a triage of two levels and according to the DGS, obstetric triage should follow a set of rules described in (Triagem Obstétrica- modelo de Triagem 2013). In this sense, it is intended that the pre-triage system should evolve to a specific system of priorities for gynecology and obstetrics with five levels of priority, in order to prioritize patients according to their clinical needs.

Obstetric Triage Acuity Scale (OTAS)

Obstetric Triage Acuity Scale (OTAS) is a specific priority triage system for gynecology and obstetrics. The OTAS was developed based on the Canadian Triage and Acuity Scale (CTAS), which is a tool that was introduced in 1999 and underwent a revision in 2006 and 2008 (Murray et al., 2004). However this tool also did not respond to the multiple situations of obstetrics and gynecology specialties. Thus, in general, the OTAS emerges as a tool that encompasses the wide variety of patients that come in obstetric triage units and gynecology (Murray et al., 2004). The OTAS is based on categorization on five levels of CTAS, as it is represented in the table 2.

For example, in the OTAS system, if patient bleeding is assessed, it needs to be categorized at several different levels. If the bleeding is associated with abdominal pain, the patient is triaged at Level OTAS 1 - Recursive. The patient gets a tag with a Red color and it is immediately accepted (Target time = 0). On the other hand, if the bleeding is scant (Spotting) the patient is assessed on the level OTAS 4 - Little Emergent (Green Color) and the maximum expected waiting time is 60 minutes (Target Time = 60)

Table 2 - Nomenclature OTAS Triage System

Name		Colour	Target Time
OTAS 1	Recursive	Red	0
OTAS 2	Emerging	Orange	15
OTAS 3	Urgent	Yellow	30
OTAS 4	Little Emergent	Green	60
OTAS 5	Non-Emergent	Blue	120

The OTAS is the first comprehensive obstetric classification tool accurately establishing reliability and validity. With the implementation of OTAS it is possible to triage obstetric patient in a standardized manner. This is a scale that has a wide application in various units of obstetric triage and emergency departments to provide care to a significant number of women (Smithson et al., 2013).

AIDA

The Agency for Interoperability, Diffusion and Archiving of Medical Information (AIDA) (Peixoto et al. 2012) (Duarte et al., 2011) is implemented in CHP. According to (Abelha et al., 2002*)*, it is based on the use of pro-active agents, and it is responsible for tasks such as communication with heterogeneous systems, sending and receiving information management, stroing the information and responding to requests for information, taking into account resources in compliance with time.
In the case of CMIN, AIDA allows interoperation between information systems. AIDA supports the Electronic Healthcare Record (EHR) in use throughout the CHP and the pre-triage system in CMIN (in MJD before CMIN inauguration).

Modelling and simulation technique

In general, modelling and simulation (M & S) consists on the use of a model, including emulators, prototypes, simulators, and stimulators, either statically or over time, to develop data as a basis for making managerial or technical decisions. The terms "model" and "simulation" are often used interchangeably. In this sense, with modelling and simulation it is possible to obtain information about how something will behave without actually testing it in real world (Ministério da Saúde, 2006) (Bowman et al., 2002). Simulation is usually cheaper and safer than conducting experiments with a prototype of the final product. There are various types of simulation such as the use of standardized simulation techniques, adapting the set of test data for these techniques or development of a simulation model itself (Tendick et al., 2000) (Grantcharov et al., 2004).

DESCRIPTION OF THE SPECIFIC SYSTEM TO VALIDATE

Based on the three triage intelligent systems presented above (MTS system, the pre-triage system implemented in CMIN/MJD and OTAS), it has been developed a specific priority triage system to gynecology and obstetrics in view of the class of patients and their clinical characteristics. Thus, this system will be supported by a specific questionnaire for gynecology and obstetrics (a different approach compared to MTS system), and consists of five priority levels. A number was assigned to each new category, such as a name, a color and an acceptable time target computed from the first contact with the medical service. The number and name were adapted from MTS, and the time target and the re-evaluation has been adapted from the OTAS, being specific to gynecology and obstetrics cases. The system have been developed for the CMIN.
The nomenclature adopted for this triage system of priorities is described in Table 3. Number is the priority level, Name is the name of the priority level, Parameter is the color of the bracelet, the Target Time is the maximum waiting time and the Reassessment is the time interval between observations.

Table 3 - Definition of CMIN /MJD Priorities Triage System

Number	Name	Colour	Target time	Reassessment
1	Emergent	Red	0	Immediate
2	Very Emergent	Orange	15	All 10 min
3	Urgent	Yellow	30	All 15 min
4	Less Emergent	Green	60	All 15 min
5	Non-Emergent	Blue	120	All 60 min

This system, once validated by the medical and scientific community, will be implemented in CMIN. As the previous system of pre-triage, this new system will cover all classes of patients of the CMIN, in an integrated way.

Variables and requirements used in the simulation system

In general this work intended to simulate the priority triage intelligent system with five levels using the specific repository of pre-triage cases for gynecology and obstetrics since 2010 in MJD/CMIN.
Although the system of pre-triage consists in six flowcharts of patients. In this paper, it will only be simulated the priorities for the case of pregnant women. In this simulation, they were only included the variables measured in the pre-triage system. These variables were used to map the flowchart of the pregnant priority system. For pregnant patients the selected variables were:

- *Weeks of pregnancy (wp)*: Gestational age is the common term used during pregnancy to describe how long the woman is pregnant.

- *Symptoms:* Represent some specific symptoms that can occur in pregnant and be related with the well-being of the fetus or the pregnant woman.
  Possibles results - *{Headache (Hd), Visual Changes (VC), Tension Increase of reference (TIR), epigastric pain/right hypochondrium (EP\RH), nausea/vomiting (N\V), changes in skin/mucous color (CS\MC), breakthrough bleeding (BB), decreased fetal movement (DFM), loss of amniotic fluid (LAF), Trauma in pregnancy (TP)}*
- *Another pathological reason (APR):* If any of the symptoms mentioned in the previous point is not found, the pathological reason the patient resorted to MJD should be pointed out in this topic.
- *General state (GS)* - In this parameter, the nurses assess the general condition of the patient.
  Possible results - *{good, bad, reasonable}*
- *Pain Scale (PS)* – It's a scale between 1 and 10 that represent the pain scale, where 1 represents the total absence of pain and 10 representing the pain as much as possible.
  Possible results – *[1,10]*
- *Location of the pain* – they are possible variables that describe the location of the pain.
  Possible results - *{No Pain (NP), Uterine Contractions (UC), Hypogastric Pain (HP), Iliac Fossa Pain (IFP), Back Pain(BP) , Other Pain (PU), Pain upper 1 week (PUW)}*
- *Symptoms* - These variables represent symptoms of a more general nature.
  Possible results - *{Fever (Fv), Blood Pressure (TA), Urinary Symptoms (US), Hemorrhage (Hm), Convulsions (Cv), Syncope (Sc)}*

The following table (Table 4) shows the distribution of the variables used in the simulation process. Here, it was analysed the percentage of positive responses given during the pre-triage process for each one of the variables.

Table 4 - Distribution of variables used for simulation, where it was presented the symptom (symp), type of response (Res) and distribution (dist)

Symp	Res	Dist	symp	Res	Dist
HD	Yes	2,74%	**NP**	Yes	0,37%
	No	97,26%		No	99,63%
VC	Yes	0,77%	**UC**	Yes	8,53%
	No	99,23%		No	91,47%
TIR	Yes	1,61%	**HP**	Yes	5,52%
	No	98,39%		No	94,48%
EP\RH	Yes	1,14%	**IFP**	Yes	0,28%
	No	98,86%		No	99,72%
v\N	Yes	3,85%	**BP**	Yes	1,19%
	No	96,15%		No	98,81%
CS\MC	Yes	0,18%	**PU**	Yes	1,82%
	No	99,82%		No	98,18%
BB	Yes	8,86%	**OP**	Yes	4,17%
	No	91,14%		No	95,83%
DFM	Yes	5,08%	**PUW**	Yes	0,11%
	No	94,92%		No	99,89%
LAF	Yes	7,55%	**FV**	Yes	52,56%
	No	92,45%		No	47,44%
TP	Yes	0,46%	**TA**	Yes	44,49%
	No	99,54%		No	55,51%
APR	Yes	20,59%	**US**	Yes	5,18%
	No	79,41%		No	94,82%
GS	Yes	9,78%	**Hm**	Yes	10,64%
	No	90,22%		No	89,36%
PS	Yes	10,59%	**CV**	Yes	0,11%
	No	89,41%		No	99,89%

As a requirement of this simulation, it was necessary perform a mapping of symptoms to a possible five levels scale, taking into account the patient clinical severity and the target time. Experts (physicians and nurses skilled in the area) helped to mapping the triage for the pregnant flowchart (gynecology and obstetric) in the CMIN context.

SIMULATION PROCESS

In order to be able to simulate a priority triage system specific for gynecology and obstetrics, two algorithms were developed in order to model the existing dataset. The methodology of mapping the symptoms and consequent algorithms were developed with the support of professional information system in collaboration with healthcare professionals (physicians and nurses) skilled in the area.
Below two different algorithms developed to address the problem are shown. The first algorithm depicted then checks usually the first symptom, initially it determines emergent cases then very emergent cases, and so on. If in the course of a flowchart, the symptoms which determines the priority is verified the questionnaire should be stopped and the level of triage should be returned. This condition is guaranteed by the condition of *break*. However, if the case is less emergent the nurse can decide to continue the triage process.

Algorithm Transformation - Gynecology and Obstetrics Triage Priorities System

Requires: symptoms

```
Function Gynecology and Obstetrics Triage Priorities System [Haemorrhage, Trauma in Pregnant, ..]
If Haemorrhage (severe)  = True
      Then Triage level  = 1
          Break
   …
   Else if Trauma in Pregnant = True
       Then Triage level  = 2
          Break
   …
  Else  if Haemorrhage (Moderate)  = True
      Then Triage level  = 3
          Break
   …
   Else if Haemorrhage (Scarce) = True
        Then Triage level = 4
            Break
   …
   Else Triage level  =5
   End if
```

```
    Return Triage level
End function
```

For the second approach, the algorithm is completely followed, it only updates the priority over flowchart triage. This update is guaranteed by the condition *Update*.

Algorithm Update - Gynecology and Obstetrics Triage Priorities System

Requires: Glasgow

```
Function Gynecology and Obstetrics Triage
Priorities System [Glasgow,..]
If Glasgow = 3
    Then Update table triage
        Set Triage Level=1;
        …
  Else if Glasgow between 4 and 5
    Then Update table triage
        Set Triage Level=2;
       …
   Else if Glasgow between 9 and 12
    Then Update table triage
        Set Triage Level=3;
       ….
  Else if Glasgow between 9 and 13
    Then Update table triage
        Set Triage Level=4;
  …
  Else Triage level =5
    End if
  Return Triage level
End function
```

Both algorithms have some advantages. In the first case, the questionnaire ends in the moment where it was verified a higher importance level (triage = 1). The advantage lies in the fact of in cases where the patient was identified with a most emergent situation, he spends less time in the triage process, since the questionnaire ends when it is verified an emergent symptom.

In the second case, the advantage is when the algorithm is traversed to the end regardless of the level of triage identified. This algorithm is very useful when it is necessary to map all the situations. In this sense, an advantage is the collection of the patient clinical information. However this approach has the option to finish the triage process when the nurse wishes, i.e., when the nurse has all information to make a decision.

SIMULATION RESULTS TO THE PRIORITY TRIAGE SYSTEM

To simulate the triage system in a virtual environment, the algorithms presented in the previous section and using real data were implemented. The prority triage system is in the final stage of implementation and tests. The following results were obtained for the last stage of model refinement. Also in this section, the results are presented for the real case of application of the pre-triage system currently in CMIN, and a comparative graph between the two versions of the triage system using the repository past data.

Application of the simulation algorithm

After developing the algorithm of priority triage in case of pregnant woman, it was possible to triage patient records in 5 levels. For this simulation about 24802 records of real patients collected between the period of January 2010 and December 2014 were used. In this period the waiting time range was between 0 minute and 240 minutes. The results of applying the developed algorithms are presented in the table 5.

Table 5 - Results of the implementation of the simulation algorithm of Triage priorities System of CMIN for pregnant patients

#	Designation	Num. of Patients	% Patients	Min Waiting	Max waiting	Target time	Avg waiting
1	Emergent	28	0.11%	0	29	0	5.32
2	Very Emergent	116	0.47%	0	33	15	6.37
3	Emergent	9304	37.51%	0	208	30	6.35
4	Less Emergent	4576	18.45%	0	211	60	6.82
5	Non-Emergent	10778	43.46%	0	219	120	6.95

Displaying the system of pre-triage of CMIN

This study was done on the same sample for the previous case, i.e. the form used about 24802 records of real patients collected between the period of January 2010 and December 2013 where the waiting time was between 0 minutes and 240 minutes. As mentioned before, this system only divides the triage output into two levels: URG and ARGO. The results are shown in the table 6.

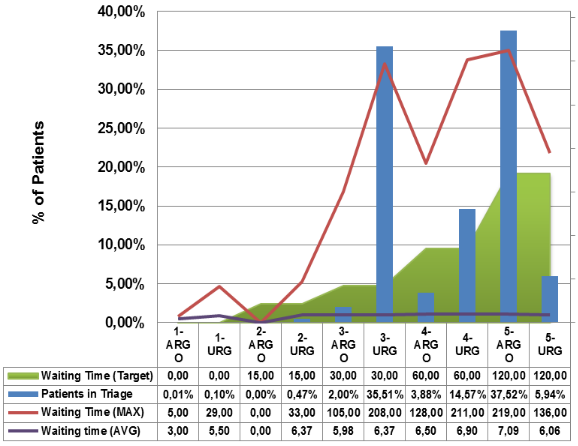
The comparison between the systems

To compare the systems a graphic using the results above was designed. In this sense, this analysis compares the results obtained by the application of priority triage simulation algorithm with the results obtained by the pre-triage system implemented in CMIN.

Thus mapping was done taking into account the outcome of the pre-triage system (URG or ARGO), results of the application of specific priorities for the gynecology and obstetric (1, 2, 3, 4, or 5) system, the time expected (Target) (Table 2 and Table 3), the number of patients used for this study, the maximum waiting time and the average waiting time, spread over triage results (pre-triage system and priority triage system).

Table 6 - Results of the pre-triage System of CMIN/MJD for pregnant patients

Level	Des.	Number of Patients	% Patients	Min wait. time	Max wait. time	Average wait. time
URG	Urgency	14036	56,59%	0	211	6.47
ARGO	Out Patient	10766	43,41%	0	219	6.98



Figures 2 - Results of pre-triage system and the simulated system, grouped by the number of patients, the maximum waiting time and average waiting time.

In the following table (Table 7), it is shown the difference between the time obtained by the simulation algorithm and the maximum time expected by the literature review (Taget time-simulation algorithm (a) and time-Taget Expected (b)). Also the deviation in percentage is shown.

Table 7 - Difference between the time obtained by the target time obtained by the simulation algorithm and the maximum time expected by the literature review (a-b) and the % of time deviation

Level	Target time -simulation algorithm(a)	Target time – Expected (b)	Deviation (a-b)	% Deviation ((a/b)*100)
1	29	0	29	0
2	33	15	18	220
3	208	30	178	178
4	211	60	151	151
5	219	160	59	59

DISCUSSION

As mentioned before, the use of an intelligent system for specific cases of gynecologists and obstetrics triage is extremely important because it allows a more efficient distribution of patients taking into account factors such as the patient's clinical status and speed response of the emergency service. After a comparative analysis between the pre-triage system (Table 6) and the simulated priority triage system (Table 5), it was necessary to consider some crucial points to the development of this project. Firstly, with the use of a specific system of priorities for obstetrics and gynecologists with 5 levels of accuracy, it is possible to perform a more specific distribution taking into account the clinical needs and services provided by the CMIN.

So following the discussion of these results it appears that the priority triage system simulated shows a better distribution between clinical features and its integration within the priority system than the existing system of pre-triage in CMIN. Specifically, comparing the results obtained in Table 5 and 6 and relating those with the parameter *% of Patients* it is possible to observe that in the case of Table 5 it was a better distribution of patients by each one of the priority levels. Also in the case of the results shown in Table 5, the *% of Patients* for the case of level 5, not emergent, (% of Patients = 43.46%) is very similar to the *% of Patients* in Table 6 to ARGO case, for out patient services *(% of Patients = 43.41%*), and so the remaining 56.59% owned by the URG (Table 6), are distributed the remaining 4 levels of priority in Table 5 (Level 1 – 0,11%, Level 2-0, 47 %, Level 3-37.51%; Level 4 - 18:45%). This means that most patients are distinguished as the URG in the pre-triage system actually they can be distributed by the four distinct priority levels. This way, a specific decision support for triage of gynecology and obstetrics with five levels of priorities will certainly bring gains in healthcare with regard to patient care priority.

In the case of *the minimum waiting time*, in both cases (Table 4 and Table 5) the value is 0 for all level. This shows autonomy and speed in responding to patients' clinical needs in the Emergency Service.

In terms of time and *Maximum waiting time* and analysing firstly this parameter in Table 5, in general the emergent situations are met more effectively and quickly (emergent-maximum waiting time = 29 minutes) and not emergent (maximum waiting time = 219 minutes). However the patterns of maximum waiting times with this dataset are not yet standardized in accordance with what would be expected from a triage system of specific priorities for pregnant women as referenced in Table 5 (target time) and OTAS (Table 2). In this case it appears that the maximum waiting time for different cases is Level 1 = 29 minutes, Level 2 = 33 minutes; Level 3 = 208; Level 4 = 211 minutes and Level 5 = 219. It is recalled that this simulation algorithm was applied to a dataset that was not screened by using the priority model, but by intelligent pre-triage system, in which a distinction was only made in two levels (URG and ARGO). Analysing now the maximum waiting time in the case of variable results for the pre-triage (Table 6) it is seen in case of URG case the time 211 minutes and for the case of ARGO the time is 219 minutes, values very close together.

With this simulation process, it was also proved the need for evolution of the intelligent pre-triage to a specific intelligent prioritization fluxogram with five levels of priority. This makes possible a better fit between the clinical characteristics and the speed of clinical response to patients' needs (maximum waiting time). This inference is verified both in Table 5 where a setting of waiting times is necessary, as in Table 6 which checks to see that in real time, the maximum waiting time between URG and ARGO is very close. With the transformation of the intelligent pre-triage system into an intelligent system with priorities for triage of obstetrics and gynecology, it is expected to verify a relation between the target time (Table 3) and the maximum waiting time (Table 5).

Finally and evaluating the average time of the two cases analysed it appears that the average waiting time is greater than the lower priority.Thus in the case of application of the simulation, the algorithm checks for whether the priority 1 = 5.32; for priority 2= 6.37 ; for priority 3=6.36 for priority 4= 6.82 and for priority 5= 6.95. In the case of the pre-triage system in CMIN, it appears that the average time in URG and ARGO levels are respectively 6.47 and 6.98. Thus it appears that the system of pre-triage (URG and ARGO) somehow is calibrated according to the priority and waiting time. The possibility of transforming this system into a specific priority syste for gynecologists and obstetrics will

increase the triage quality and bring benefits at the level of priority treatment, being the patients scheduled according to their clinical characteristics. These findings above discussed can also be taken by observing the graph 2, which represents all variables referred in the discussion.
Though, the system of pre-triage is good to identify ARGO and URG cases in terms of time, and applying the simulation algorithm it was verified that pregnant sometimes exceed the maximum waiting time, and that value is in approximate average of 121.6%. These values confirm the benefits of a triage system of priorities.

The system is also good to identify cases of URG and ARGO in terms of the maximum waiting time, when applying the simulation algorithm, as noted in Table 7, it is also possible to observe from the percentage deviation between the maximum waiting time obtained by the simulation algorithm and the maximum waiting time obtained from bibliography review, that sometimes pregants exceed the maximum waiting time, and that value is an average of approximately 121.6%.

CONCLUSIONS AND FUTURE WORK

The pre-triage system implemented in CMIN was induced by following the MTS terminologies already implemented in the general emergency of the HSA. The difference is in the fact that this system of pre-triage is conducted by a specific questionnaire for gynecology and obstetrics. With the state assignment and the questionnaire output: URG or ARGO it was possible to categorize the patients into two levels of priorities according to the severity state. The emergent cases (URG) were not supported by any parameters to prioritize them according to their clinical characteristics. In this sense the development of this simulation algorithm which aims to simulate an intelligent decision support system for specific priority triage system for case of pregnant woman proved the need for evolving the system from an intelligent system pre–triage into a specific priority triage system with five levels of priority.

As it is well known computational simulation of physical systems is popular in both the scientific and academic area (technology development in the fields of medicine, physics, chemistry and engineering) as the optimization of logistic systems. It is an important tool because it allows confront theory, based on concepts and mathematical models with the experimental part. The process of decision making can be monitored, analyzed and evaluated. Physical systems and solutions for improving the design, thereby allowing the prediction of some experimental results, van be tested. In this particular context, simulation brings benefits in terms of time and money. In secure, inexpensive and practical way, it was possible to simulate a priority triage system. Actually, it proved the needs of introducing a new system (extending the current) without extra costs in developing and testing a possible solution.

In general, the approach presented in this article proved the need for the existence of a Priority Triage System for specific cases of gynecology and obstetrics, It is a starting point for the implementation of a specific triage system of priorities for gynecology and obstetrics as it is currently suggested by DGS ("Triagem Obstétrica- modelo de Triagem," 2013). This model is being applied in CMIN, the initial idea can be extended to other health institutions with similar characteristics to the CMIN. As future work, it is intended to implement the priority triage system for gynecology and obstetrics in CMIN. This system will be based on the simulation algorithm presented in this paper. Later it is intended to refine this algorithm adding new variables. These variables will be added in the transformation process, which were not included in this study because currently they are not recorded in the pre-triage system. An example is the variable prolapse of the umbilical cord.
After deploying all the new triage system, the existence of new real clinical records allow to perform new simulation systems in order to evaluate the system and study possible improvements focused in the innovative priority system.

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