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Semi-automated management of defining the case priority in the flu epidemic season for emergency medical service

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Abstract
To help resolving increased problems of emergency medical service of Georgian Emergency and Operative Response Center - MIA LEPL "112" in the flu epidemic season a special algorithm is created. Aiming to make easier the emergency dispatchers' work the algorithm is applied to define the case priority semi-automatically. The algorithm can be used in self-teaching computer system. The values of parameters used in the algorithm are easily detectable from the standard case-cards usually filled by a call taker for emergency medical service. As it is shown in the pilot results, the accuracy of case priority line defined by using the algorithm is close to the one made up by professional medics.

Keywords: *dispatching, ambulance, algorithm, flu, case, priority, emergency.*

1.Introduction

Developing of computerization and machine learning gets popular in many spheres of our life. Especially it concerns medicine due to much increased recent challenges. Computerization of routine medicine is absolutely necessary nowadays. Implementing of modern software techniques is especially important to organize a proper emergency medical service.

Being a programmer at the Emergency and Operative Response Center "112", I paid attention to the annual problem of flu seasons. Emergency case messages for medical service usually enter the "112" center. The "112" call-taker registers the case-card containing information about a particular patient. Afterwards such cards are sent to dispatchers of ambulance brigades [1].

Greatly increased number of calls for ambulance brigades causes serious complication of their dispatching. Sometimes up to 50 calls may be waiting in line for the emergency brigades. Besides the permanent deficiency of ambulance cars, dispatchers have usually got problems in defining case priorities in a reasonably short period of time. Having in mind certain human factors such as nervousness, being tired, stressed etc., dispatchers can't avoid errors in the process of estimating case priorities and aren't always able to reveal the most urgent cases in a short time.

The recent research aims at the optimization of emergency medical service by helping the ambulance brigade dispatchers to make a proper decision in a reasonably short time. A special algorithm is applied to process case-card information and supply the dispatcher with its result – automatedly defined line of case priorities.

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2. Defining the case priority line

Having in mind to automate the process of defining the case priority line, it is necessary to make the following steps:

- Aiming to form the dataset easily afterwards, choose the proper parameters to be fixed by call takers: age, gender, temperature and other clinical symptoms (e.g. shortness of breath, vomiting, diarhea…), accompanying disease (e.g. diabetus, hipertony…) or particular condition (e.g. pregnancy) [2,3].
- Give weights to the chosen parameters. At the first stage of research it should be done after consultation with professional medics.
- Create algorithms to calculate the priority coefficient of each case based on predefined weights mentioned above.

  An example of such an algorithm is presented in figure 1.
- To make the system self-educative the calculated priority coefficients are compared with their real meanings defined according to the diagnosis made by ambulance brigade medics. The medics' diagnosis is considered to be correct. So the optimal decision is assumed to be the one closest to the line of case priorities made up according to the medics' opinion.

As it is mentioned above, it was decided to start the research with flu-season cases, the flu-season problem being active from the point of view of medicine. See the figure 1.

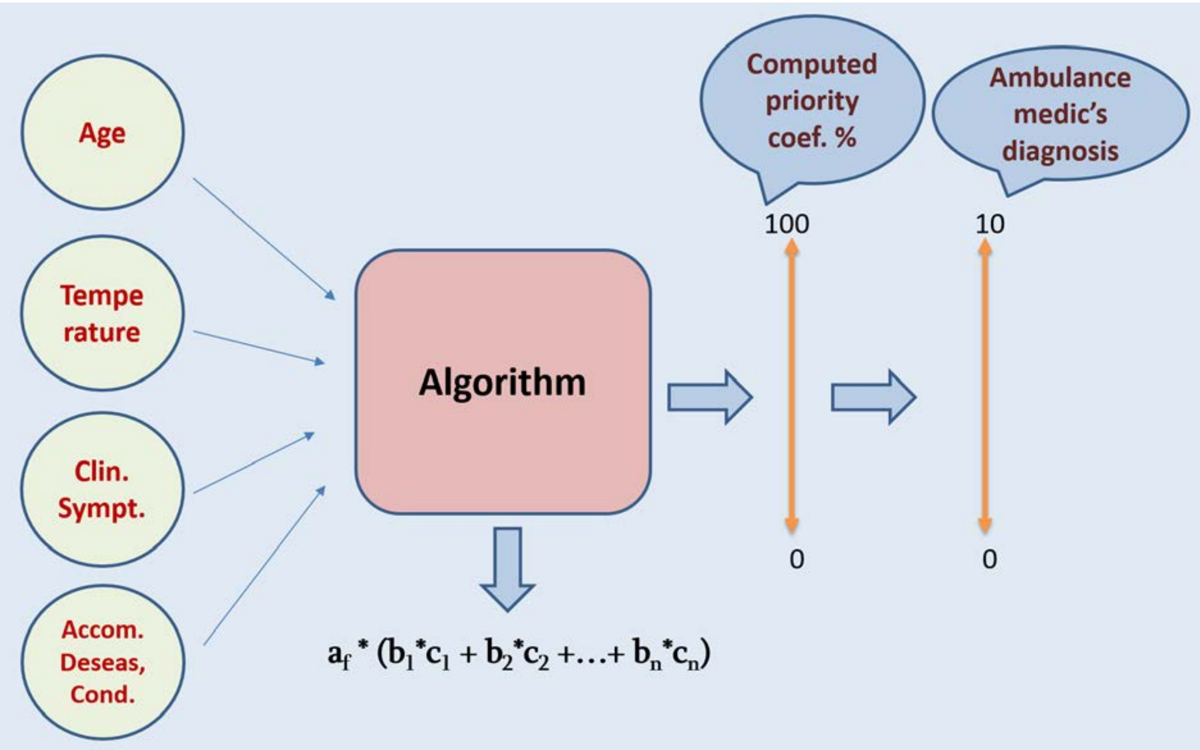

Figure 1. Scheme of automated defining of case priority coeficients.

Algorithm formula is general and can be applied to other parameters as well:

$$a_f * (b_1*c_1 + b_2*c_2 +…+ b_n*c_n)$$

where a_f has the meaning of a weight of "flu" incident type, $b_1,b_2,…b_n$ are the weights of corresponding $c_1,c_2,…c_n$ parameters (age, temperature, clinical symptoms, accompanying diseases or particular conditions, such as pregnancy) (See fig. 2). The pilot information about the relative importance of each parameter is given by professional medics beforehand for each incident type. The relative importance of parameters can be estimated by and by in the process of self-teaching. Two different variants of algorithm are shown below (fig. 2) for cases of flu incident type. In the first variant all the parameters are assumed to be of the same relative importance each of them being 25%. According to the second variant of algorithm the calculation is carried out assuming the

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different relative importance of the parameters: age – 20%, temperature – 30%, clinical symptoms – 30%, accompanying diseases and conditions – 20%.

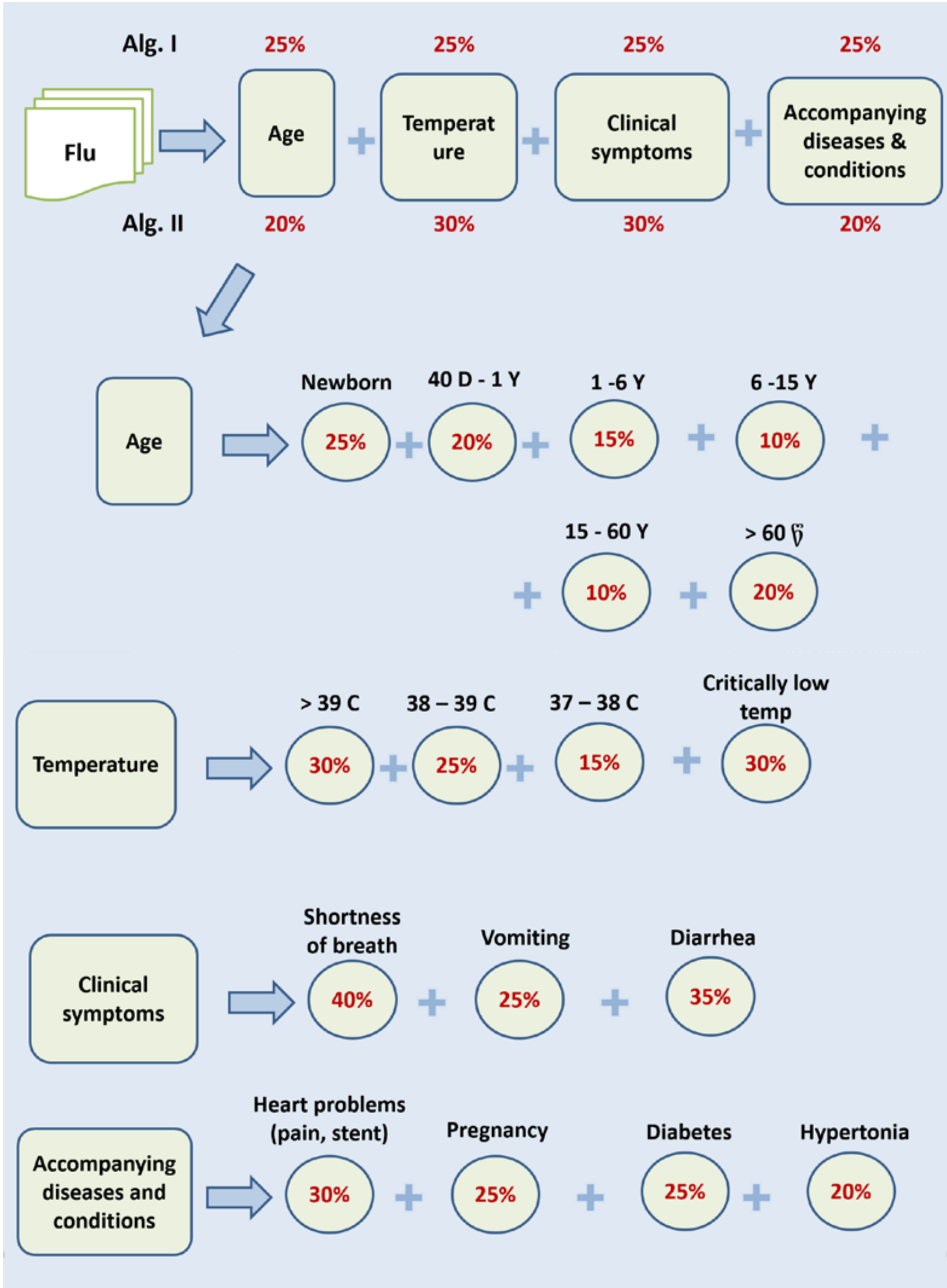

Figure 2. Weights of parameters (Age, Temperature, Clinical symptoms, Accompanying diseases and conditions) used in “flu” incident type case-cards are shown in %. Two variants of algorithm are provided to define case priority line.

The diagnosis recorded by the ambulance brigade medics, should be fixed after each case to be compared afterwards with the results of automated priority line. The algorithm could be adjusted based on the collected history and each of its following decision will be more and more close to the decision of the emergency medics.

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3. Results and discussion

As an example, the results of applying two variants of the algorithm for flu cases are shown in the table below. The meaning of priority coefficient (P_c) of each case is calculated according to the formula:

$$P_c = b_1*c_1 + b_2*c_2 + b_3*c_3 + b_4*c_4$$

P_{c1} and P_{c2} mean the values of computed priority coefficients of the flu cases of 10 patients presented in the table below. The meanings of b and c parameters are given in figure 2.

patient	Age years, Gen (F,M)	High Temp °C	Other Sypmtoms	Addit. illnesses and condit.	Med diagn. D_m 0-10	Comp. priority coef. Alg.I P_{c1}%	Comp. priority coef. Alg.II P_{c2}%	Priority line Numbers		
								P_m	P_1	P_2
A	61 F	39.2	headache		1-2	12.5	14	10	9-10	9
B	2 M	38.3	Vomit.		5	16.25	18	6	7	7
C	5 F	38.5	Diar.		4	18.75	21	7	5	5
D	72 F	38.7	Sh. breath	Art. pr	9-10	26.25	27.5	2	2	2
E	63 m	39.2	Sh. breath	Heart pr.	10	30	31	1	1	1
F	8 M	39.1	Sh. breath		8-9	20	23	3	3-4	3-4
G	55 F	38.2	headache	Diabet	1-2	15	14.5	9	8	8
H	12 F	39.5	Sh. breath		7	20	23	4	3-4	3-4
I	0.16F	37.9	Diar.		6-7	17.5	19	5	6	6
J	36 F	37.8	Headache	Pregn.	3-4	12.5	11.5	8	9-10	10

Priority line numbers P_1 and P_2 (see the table) are created according to the results of computing the values P_{c1} and P_{c2}. The more the value of P_c the more urgent is the case, being more forward in the priority line. Priority line number P_m corresponds to the medical diagnosis estimated by D_m score showing the heaviness of the case.

As it is seen from the table, the first 4 cases in priority lines are equally estimated by computer algorithms and ambulance medics. There are only small differences in most other cases as well. Significant differences are seen only in two cases. But one must have in mind the small size of the dataset of this preliminary research. To get statistically reliable results, the work on much more large datasets is to be carried out in future. Besides, the large datasets are necessary to improve the algorithms.

In the end, some difficulties characteristic for such kind of work should be mentioned.

Subjectivity in defining case priorities – The information got from ambulance medics can be subjective due to the existance of difficultly diagnosed cases.

Incomplete information – It often happens that the information registered in case-cards is incomplete.

Unstructured data – During the processing of the information from the case-cards, the most dificult is to deal with the unstructured data [4] (for example an important information added as a comment). In such case we need to think of a specific approach not to loose the important information.

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To eliminate the problems mentioned above, it is planned to apply the ProQa system for improving recording the information in the case-cards. ProQA Dispatch Software integrates the power of the International Academies of Emergency Dispatch's protocols with today's critical computer technologies[5]. Besides, ProQa system provides more objective preliminary information needed for adjusting the algorithms of defining the case priority line.

4. Conclusion

The results of the preliminary research show that application of computer systems and algorithms make it possible to improve the work of ambulance brigade dispatchers providing them with the case priority line defined quite accurately. The accuracy of the case priority line defined using the special algorithm appeared to be close to the one made up by professional medics. For the further adjustment of the algorithms and improvement of reliability, the research should be carried out on a larger scale, processing large datasets and using proper statistical analysis.

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Amount of Table: 1

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