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Emergency medical coordination using a web platform: a pilot study

ABSTRACT

OBJECTIVE: To describe a management system for emergency medical coordination based on the worldwide web of computers.

METHODS: The emergency coordination system was developed according to an evolving software model for prototype development. Communication between users and the system was implemented by means of web technologies. The system was developed on a personal homepage and the database was developed using MySQL. The prototype was based on the medical coordination process of the Thirteenth Regional Healthcare Division of the State of São Paulo (Southeastern Brazil) and was applied to 26 municipalities within this regional division, for four consecutive weeks in September 2009. The system made it possible to document requests in chronological order, without allowing editing of data already entered, and ensured hierarchical confidential access to the information for each participant in the system.

RESULTS: The system presented 100% availability, reliability and integrity of information. A total of 1,046 requests were made to the system, of which 703 (68%) were completed. The solicitants already presented 98% adherence to the system in the first week of application, while adherence among service providers gradually increased (37% in the fourth week). The municipalities closest to Ribeirão Preto that did not have high-complexity providers were the ones that most used the system.

CONCLUSIONS: Medical coordination of emergency requests through the worldwide web of computers was shown to be feasible and reliable, and it enabled transparency within the process and direct access to information for managers. It allowed indicators to be constructed in order to monitor and improve the process, from the perspective of creating semi-automated coordination and advances in system organization.

DESCRIPTORS: Software. Computer Systems. Health administration. Emergency Medicine. Evidence-Based Emergency Medicine.

INTRODUCTION

The hierarchical organization of the Brazilian National Health System (SUS) is being consolidated and alternatives for ensuring fast and easy communications between its constituent institutions are being sought. The National Emergency Attendance Policy lays down that the service provision network should be organized such that it forms part of the coordinated complex of SUS and promotes interchange with other sectoral information subsystems. Such interchanges make it possible to continually implement and improve data production and democratization of information to feed into health promotion strategies.

Solid implementation of this policy has not yet been achieved. Inadequacies within this stage have led to attendance overload at institutions and disservice for users, who receive inadequate attendance or incorrectly referred to institutions that are poorly prepared to receive them.¹² These inadequacies may be structural (lack of basic conditions for attendance) or due to excess demand on the structure or inadequate allocation of the demand on it. Even if the structure is expanded because of the demand, incorrect use of the structure generates enormous losses. One example of this is the use of emergency services by users who could have been attended by other sectors if they had been functioning adequately.

The Thirteenth Regional Healthcare Division of the State of São Paulo (DRS-XIII), in Southeastern Brazil, was one of the pioneers in installing a medical coordination system to organize the flow of patients between the different levels of complexity of the healthcare providers within the region.¹³ Nevertheless, despite the accumulated experience of the last ten years, this Regional Division is facing problems consequent to lack of beds, inadequate referrals and difficulties in reconciling work scales, and problems in qualifying the coordinating physicians. One of the main bottlenecks in the system is the difficulty in producing effective and speedy documentation for the coordination process that would enable continual supervision of each case and continuous development of quality indicators.

DRS-XIII is composed of 26 municipalities and includes an estimated population of 1.2 million inhabitants, of whom half are in the municipality of Ribeirão Preto. This municipality plays an important role in attending emergencies within DRS-XIII, partly because of lack of resources among the smaller municipalities and also because of the presence of the emergency unit of the teaching hospital (Unidade de Urgência e Emergência do Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo – UEHCFMRP-USP). It forms a reference center for high-complexity procedures in many specialties.¹³

For ten years, DRS-XIII has had two medical emergency coordination centers, of which one was exclusively for Ribeirão Preto. Requests for beds among SUS service providers are made by telephone, which makes the process difficult for the coordinators, given that they make many calls to find out what the bed availability situation is, and for the service providers, who have to deal with two centers.

Information technology tools have considerable potential to help in solving these problems.⁷ Recently, the Ribeirão Preto School of Medicine instituted an undergraduate course on Biomedical Information Technology to train information technology professionals with knowledge of healthcare processes.

This has provided human and logistic resources for developing a medical coordination program based on the worldwide web of computers, and for testing it over a consecutive 30-day period within DRS-XIII. The study was motivated by the premise that real-time availability of information would speed up the patient allocation process, facilitate dialogue among the healthcare players participating in the system and enable systematized data gathering so that corrective measures could be taken by the system controllers.

The present study aimed to describe the medical coordination and management system based on the worldwide web of computers.

METHODS

The emergency coordination system (SRUE) was developed according to an evolving software model for prototype development. Communication between users and the system was implemented by means of web technologies. The system was developed on a personal homepage and the database was developed using MySQL. The initial prototype was drawn up in accordance with the work of the coordinators within the medical coordination complex of DRS-XIII. After the initial prototype had been presented, the technical necessities were evaluated and suggestions were made and incorporated into the system. The evaluation and development sessions were conducted interactively until the prototype had been stabilized and the final version had been created.

The SRUE was developed for immediate communication among the units participating in the medical coordination process. The process begins with a request for a bed made by the attending physician, named the “Solicitant”, by means of filling out a form giving demographic and clinical history data and stating the care resource requirements. Each municipality within DRS-XIII has one healthcare center as its emergency base, except for Ribeirão Preto, which has five reference points. All the physicians acting in these units are considered to be “Solicitants” by the emergency coordination system. The data would be sent to the coordinating physician, named the “Coordinator”, who evaluates the information and categorizes the severity as low, moderate or high priority, or as “no beds”, and sends the request onwards to the most appropriate hospital, named the “Provider”. If the information is insufficient, the Coordinator would ask adjustments to the Solicitant. The Provider evaluates the request and classifies it as accepted, refused or further information required. Independent of this decision, the request returns to the Coordinator in order to continue the process. In cases of acceptance, the patient is referred to the Provider. If further information is required, the Coordinator sends the case back to the Solicitant for the data to be

completed. In cases of refusal, the Coordinator can forward the request to another Provider or can send the patient under “no beds” conditions if the patient is at immediate risk. This process reflected the decision tree used by the coordinating physicians of DRS-XIII that previously had been implemented exclusively by telephone. The whole negotiation process is confidential and documented, allowing individual identification of each professional through personal access passwords. The managers at the participating institutions have access to the information and are responsible for registering their respective professionals, but they are not given the option of initiating actions.

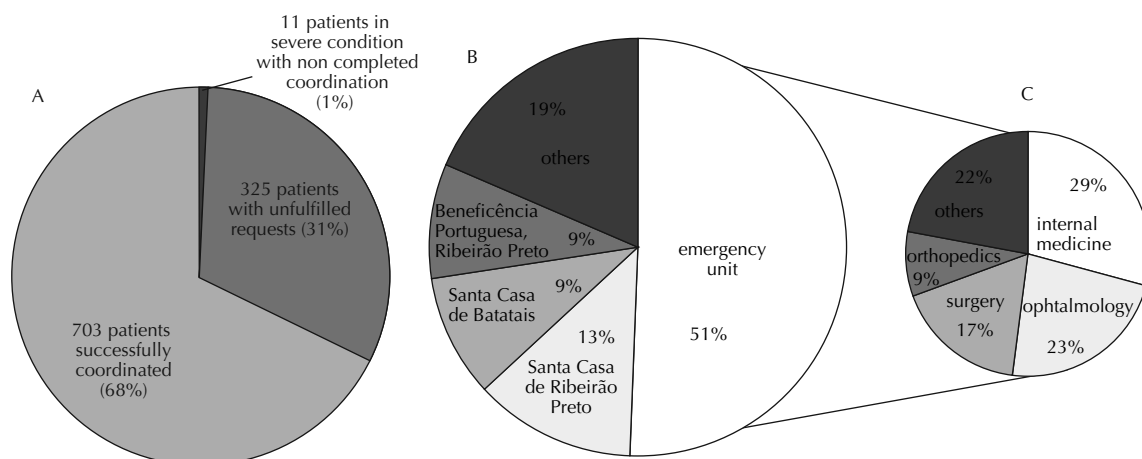
Other tools are made available by the system, such as the complete coordination history, user guidance manual and a communication system for sending in criticisms and suggestions, and for documenting problems. After concluding the coordination process, in cases of acceptance, the system allows the Solicitant to generate and print a referral form, with information from the SRUE and an identification number within the system, which the patient will take to the Provider.

The pilot project was approved at the 41st Extraordinary Meeting of the Regional Inter-manager Committee for Macroregional Coverage of DRS, on August 21, 2009. The coordinators at the DRS-XIII coordination center were trained to use the software, with guidance provided in person during the first week of the pilot project and remotely during the remainder of the process. While carry out the pilot project, over a consecutive four-week period in September 2009, as determined by the Health Department of the State of São Paulo, the medical coordination at night and

weekends was centralized in the city of São Paulo, Southeastern Brazil. This centralization created the need for training and supervision of the Coordinators in the city in the manner presented. The managers of the SRUE were the health secretaries of the municipalities within DRS-XIII, who registered the physicians on duty in their respective municipalities as Solicitants, and the managers responsible for the service-providing institutions (hospitals), who registered their physicians on duty as Providers. Since the UEHCFMRP-USP presents specific characteristics, different types of Provider were created for this institution: clinical medicine, surgery, ophthalmology and others, and the coordinator of this emergency unit (Manager) attributed specific functions to the institution’s physicians.

To make it easier to view the process, the screen of the SRUE presents the cases in different colors according to the priority defined by the Coordinator. Requests under “no beds” conditions, which required “forced” transfer to hospitals because of immediate risk of death or loss of function, are presented in dark red in order to alert all participants. Any intercurrency inserted in the system is presented to the users as a blue dot, thus signaling that action by another user is needed. The SRUE also presents the number of times that a request was denied, along with the date and time of the last intervention.

Quantitative analysis on the use made of the SRUE was performed, assessing the participation of the Solicitants, Coordinators and Providers. The availability of the system was also analyzed (access by users; in accordance with the provider), along with the reliability and integrity of the information coordinated by the system (evaluated using devices within



Note:

A) distribution of proportions of patients for whom coordination was requested;

B) institutions that received the patients for whom coordination was successful;

C) distribution of clinics that received the patients who were attended by the emergency unit of the teaching hospital;

Figure 1. Proportions of patients for whom coordination was requested and effected through the system. Ribeirão Preto region, Southeastern Brazil, 2009.

the system and through notifications of interurrences made by users). The numbers of requests, contacts made for each request, cancelled requests and destination of the requests made were extracted. The data on the requests accepted are stored in a database, which made it possible to analyze the time that elapsed between acceptance of the request and the patient's arrival at the service. Qualitative analysis was conducted on the suggestions, criticisms and problems encountered by the users while they were using the system.

The categorical variables were expressed as percentages and the quantitative variables were expressed as means and standard deviations, i.e. as central trend measurements. In the cases in which non-normal distribution patterns were observed, or in cases of divergent values that might influence the central trend measurements, medians and interquartile intervals were used. To compare categorical variables, Fisher's test or the chi-square test was used. For continuous variables, analysis of variance (Anova) or the nonparametric Kruskal-Wallis test was used. For all the tests used, statistical significance was taken to be indicated by $p < 0.05$. To analyze the data and construct graphs, the Stata software version 10 was used. The geoeidemiological analysis was performed using the Spring software.² The quality

of the SRUE was based on the criticisms, suggestions and interurrences registered by the users.

RESULTS

The SRUE presented 100% availability (access for users) and did not present any failures of reliability or integrity of information.

In total, 1,134 users were registered and 1,046 requests were made to the system. Among these requests, 32% were not completed: 1% because of severity and 31% because of cancellation of requests, patient dropout or resolution at local level, or because they were psychiatric cases (Figure 1A). Among the 703 patients for whom the coordination was completed, 51% was admitted to the UEHCFMRP-USP (Figure 1B). The specialties most frequently sought at this hospital were clinical medicine and ophthalmology (Figure 1C). The municipalities closest to Ribeirão Preto that did not have medium and high-complexity Providers were responsible for the largest number of requests (Figure 2).

After the initial training, 98% of the requests were made by the Solicitants through the emergency coordination system, without intervention by the Coordinator,

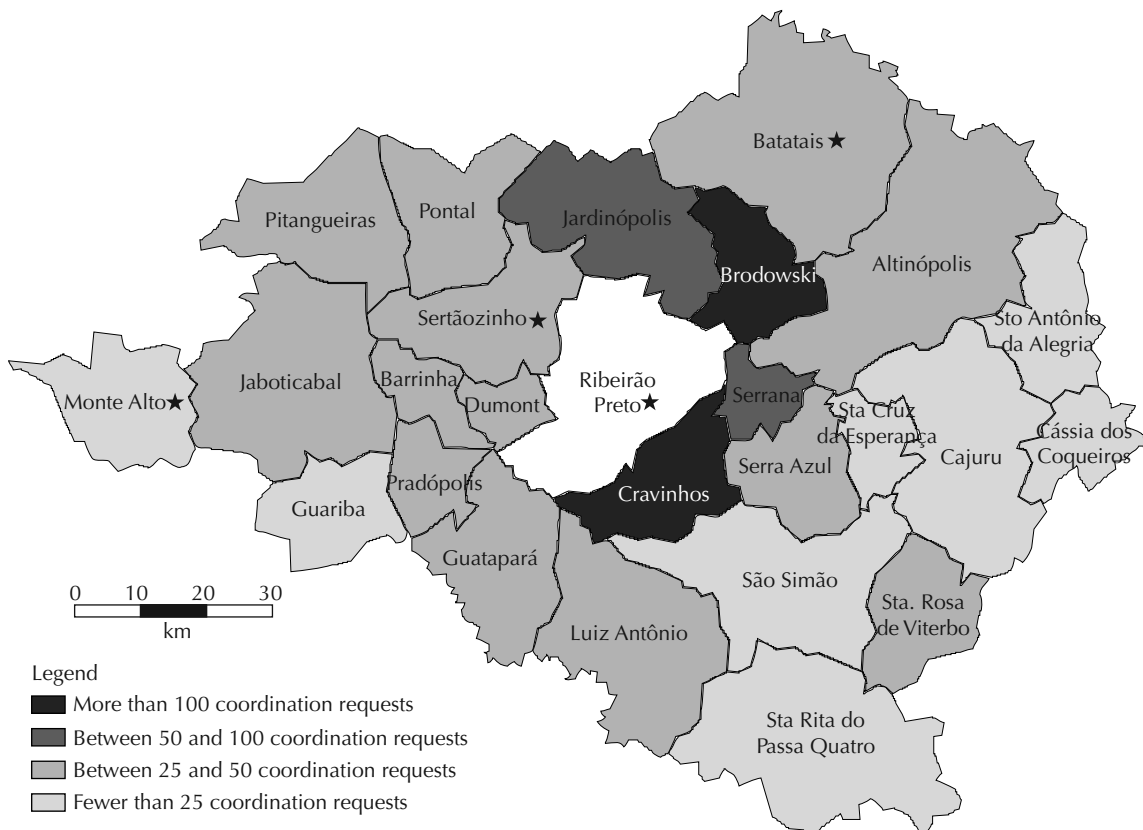
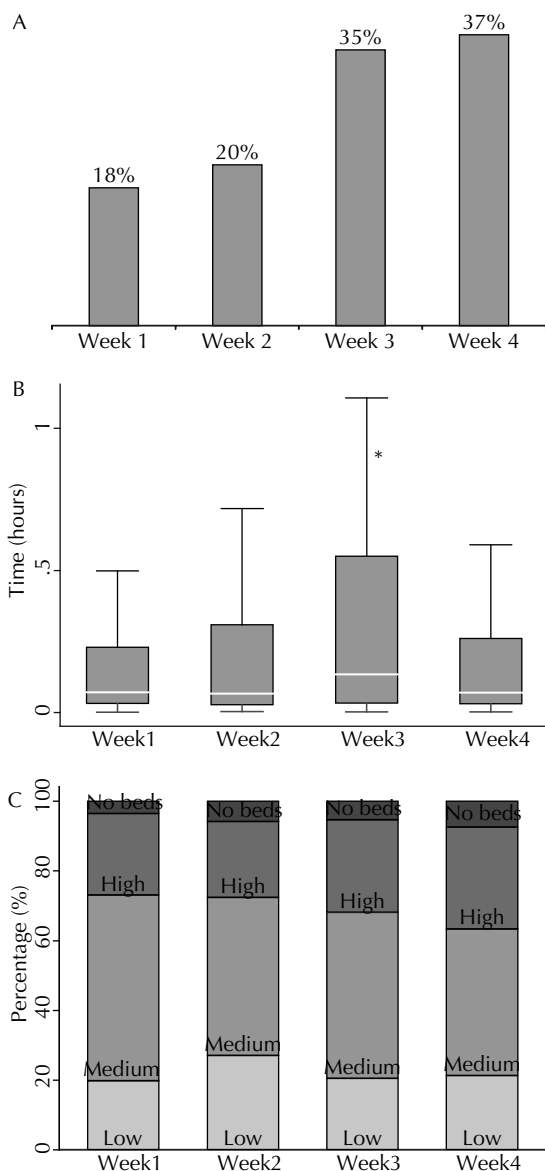


Figure 2. Geographic distribution of the number of coordination requests effected in the municipalities. Ribeirão Preto region, Southeastern Brazil, 2009.

independent of the week of the study. The mean rate of direct acceptance by the Providers, without intervention by the Coordinator, was 28.8%. The providers progressively increased their use of the system over the weeks of the study (Figure 3A).

The median time taken to coordinate the requests was greatest in the third week, compared with all the other

weeks (Figure 3B). There was no difference in relation to case severity that would explain this finding (Figure 3C). Although there was no statistical difference, there was a tendency for cases to be classified as “no beds” after a high number of attempts to communicate (Figure 4A). This was also observed in terms of the greater time that elapsed between the request and acceptance by the Provider in situations of “no beds” (Figure 4B). The



* statistically significant ($p < 0.005$).

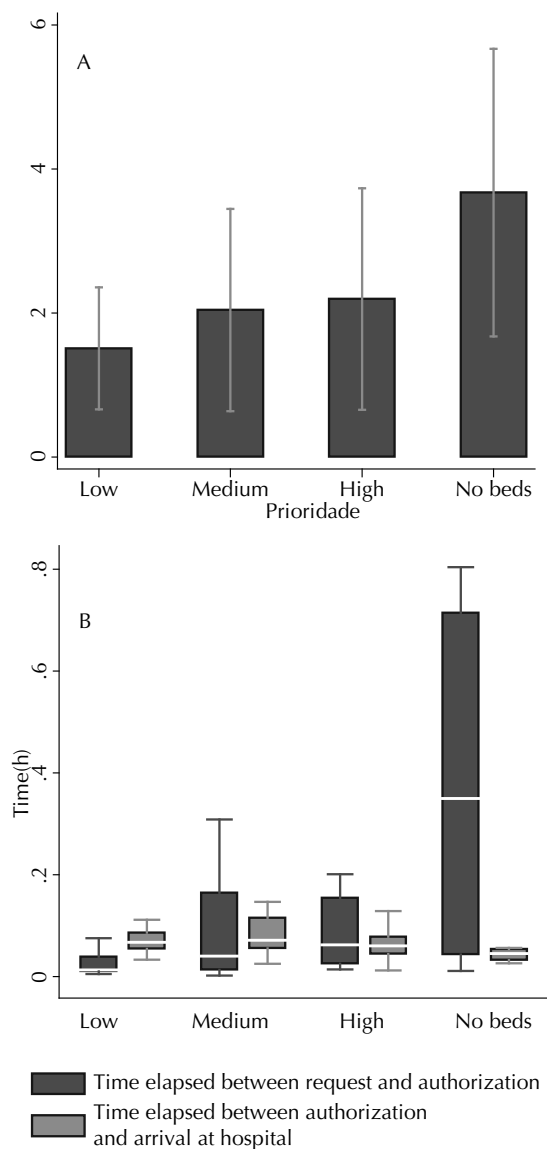
Note:

A) Proportion of the cases accepted directly by the Provider;

B) Box plot of time in hours;

C) Proportions of degrees of severity among the cases coordinated.

Figura 3. Distribuição de parâmetros de interesse de acordo com a semana de estudo. Região de Ribeirão Preto, SP, 2009.



Note:

A) Distribution of means and 95% confidence intervals for the number of contacts made by the Coordinator before making the transfer to the destination institution;

B) Time elapsed between the request and the authorization, and between the authorization and the admission of the case, for the cases coordinated into the emergency unit of the teaching hospital.

Figure 4. Distribution of parameters of interest according to severity of cases that were successfully coordinated through the system. Ribeirão Preto region, Southeastern Brazil, 2009.

time taken between case acceptance and arrival at the hospital was small in all situations, among the cases coordinated by the UEHCFMRP-USP (Figure 4B). The Table presents the most illustrative cases, grouped according to representation categories.

DISCUSSION

The structuring of emergency care varies according to the healthcare policies that are in force. Some models, characterized by spontaneous demand, are called “open door” models. Others, with hierarchical referral systems, are defined as “closed door” models.^{1,4,5} The latter are characterized by hierarchical organization of attendance in accordance with the complexity of the resources needed to care for patients.^{1,4,7,13,14} Referral models coordinate but do not make it impossible for

there to be spontaneous demand. One model may predominate within the healthcare system, and the “open door” model is more prevalent in Brazil.

The “open door” system presents problems in relation to matching demand to capacity and directing patients with specific needs to hospitals with the necessary resources. Organizational models such as risk classification and the establishment of catastrophe policies are initiatives aimed at coping with excessive spontaneous demand.^{5,15} In turn, individualized needs have been structured mainly for situations of greater prevalence and severity.^{6,8,11}

In January 2000, a process of organizing the flow of emergency patients was started in the Ribeirão Preto region, with the installation of the Unified Medical

Tabela. Analysis on case of criticism, suggestions and interurrences registered in the emergency coordination system by users. Ribeirão Preto region, Southeastern Brazil, 2009.

Type	Description	Action/comment
Real-time adaptation of the system	Transfers sent in the names of other physicians: in the first weeks of the study, transfers were accepted in the names of other physicians because of inadequate understanding of the physicians' names by the Coordinator. This happened because requests were accepted by the Coordinator and not by the Provider.	In the design for the new version of the emergency coordination system, the search for the physicians' names will be done through their registrations in the Regional Medical Council, directly in the database supplied by the Council. This will reduce the possible errors. It is also expected that, as Providers start to accept cases through the emergency coordination system and Managers become involved in the registration of their Providers, there problems will be overcome.
	Proof of transfer did not differentiate “no bed” conditions from accepted transfers: at the start of the process, the proof that was generated only inserted the data on the patient and physician in a standard letter. Letters were generated in which it was shown that the institution had accepted the patient, while in the system, it was documented that the case was one of “no beds” condition.	The acceptance characteristics were included in the letter generated, which started to highlight the cases coordinated as “no beds” conditions.
Feedback from Providers	Characterization of the role of physicians who worked in different services: there were cases of physicians who worked as a Solicitant in one institution and as a Provider in another. Since the physician had received only one login and one password, he was registered with the information on the institution in which he made his first registration, thus making the coordination impossible when he was in the second institution.	Different logins were provided for these physicians: one as a Provider and the other as a Solicitant. In the next version of the emergency coordination system, this will be corrected definitively.
	Characteristics of the patient admitted did not match the information provided: the request stated that the patient was in a critical state and so the Coordinator sent the patient under “no beds” conditions to an institution. Upon arrival at the institution, however, the patient's situation was not as critical as described.	This type of occurrence did not imply any action by the system, but it enabled creation of indicators that might favor actions by the manager. This is to be implemented as managerial reports in the next version of the system.
Supervision of coordination process by Managers	Manager in one of the municipalities asked the on-duty physician why a patient had not been transferred: the manager in one of the municipalities was monitoring the system from his home during one weekend and called up the on-duty physician to ask why a patient who was logged in the system as having a bed allocated by a provider had not yet been sent there.	This demonstrated the potential of the system as an effective real-time tool.

Coordination Center. The process was based on the SUS legislation, with public access, and it gradually evolved into an intermunicipal referral system. Initiatives for improving the performance of the healthcare players involved were documented.^{3,9,14} Although this was established around a decade ago, there are no computerized data that would provide real-time information for promoting adaptations to the system.

The development of a computerized management tool has been a long-term process that initially sought to ensure that the complex documentation was reliable and to adapt the users to the system. The SRUE was shown to have high availability, reliability and integrity of information, and continual supervision by the researchers of the project ensured continuity of the coordination processes, even with the large volume of requests that were made over the study period.

The SRUE was rapidly incorporated into use among the Solicitants and Coordinators, but its acceptance among the Providers was slower. Because the Solicitants and Coordinators were small groups of professionals, training and adherence to the program may have been easier to achieve. On the other hand, there was great dissatisfaction among the Solicitants with the current process of medical coordination by telephone, and in particular with the delay in attendance. The SRUE ensured that the requests became independent of telephone attendance, although this means of communication was maintained as an alternative for cases of failure of the system. The clinical teams of the Providers in Ribeirão Preto consisted of on-duty physicians in a variety of medical specialties, unlike in the American model, in which there are emergency physicians. This fragmentation of attendance may explain the delay in acceptance of the process of the SRUE. In the particular case of the UEHCFMRP-USP, the Coordinator had to separately access different specialties, thereby causing difficulties for the medical coordination process. As an aggravating factor in the present situation, there are organizational differences between the various Providers, with specific formats for each specialty, and the decision on whether to accept cases or not often falls on members with lower experience. These characteristics of the Providers made it difficult to identify the physicians to be registered in the system. The coordinating physicians were already aware of these problems, which have been on the agenda for discussions at meetings of regional managers. Full installation of the tool may provide transparency for the problem, thus making it possible for Managers to discuss how many interlocutors there should be within the coordination process. The high number of interlocutors (1,134 users) is a complicating factor in the process. Updated registrations for these professionals will make it possible to discuss the type of interlocution with each institution and ensure the possibility of electronic dissemination of information. In this way,

these professionals will be kept up to date in relation to problems and changes within healthcare policies.

The SRUE enabled objective and easily retrievable documentation for the entire coordination process, along with providing a variety of reports, such as on the distribution of requests per municipality. It is thus a powerful epidemiological and organizational analysis tool for the future. The pilot study helped to centralize the coordination system. Transferring the coordination to the municipality of São Paulo at nights and weekends enabled analysis on certain matters, especially the transfer of information on cases. In DRS-XIII, like in other regional healthcare divisions, data on pending requests during the day are informed by fax to the center in São Paulo, for the process to be continued. During the pilot project, such information was automatically transferred to São Paulo as soon as the Coordinator of this center had connected to the system. This resource has great strategic potential, insofar as it can ensure that coordination centers take on the process of patient transfer during crisis situations, independent of their geographic localization. However, with the centralization of coordination in São Paulo, it was noted that the time needed to complete the process increased significantly, probably because the Coordinators in São Paulo were unaware of the resources available and the characteristics of the municipalities that make up DRS-XIII.

Analysis on the documented cases also allowed evaluating the potential for communication between the players in the system and the tool administrators, thus making it possible for comments, complaints and suggestions to be documented and turned back into improvements. Efficient communication among the coordination participants may be useful for reducing the numbers of conflicts, which are common in this process.

There remains a need for future improvements in the SRUE tool. The first version developed only included open fields, for free insertion of patients' data. Future versions could be developed such that specific information would be inserted in the form of protocols for each syndrome or diagnosis.^{3,8} This information could be fed into decision-making flow diagrams that take into consideration aspects of the disease and the installed capacity of diagnostic and therapeutic resource, as well as using the adapted experience from risk classification systems.¹⁵ These flow diagrams will allow the coordination process to be semi-automated and will allow the Coordinator to take on the role of mediator and supervisor, thereby interfering in the process only in situations in which the SRUE would not be capable of concluding the transfer automatically.¹⁰ Simulations on historical databases may help to define the cost-effectiveness of innovations and investments in continual development of the SRUE and application of resources to expand the installed capacity.^{5,7,8,10}

The lack of similar experiences in Brazil and worldwide makes it impossible to compare it with other systems. The models that exist in the literature relate to catastrophe situations or to separate models of common illnesses.

In conclusion, medical coordination of emergency requests by means of the worldwide web of computers was shown to be feasible and reliable. It also ensured transparency within the process, inclusion of participants within the system development and direct access to the information for managers. The SRUE made it possible to construct indicators that allowed monitoring

and improvement of the process, with the perspective of creating semi-automated coordination and achieving advances in the organization of the medical emergency system in Brazil.

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