Systematizing medical alerts

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Abstract. The current Swedish regulations for medical alerts in health records were designed for paper records. Suggestions for computerized systems are now being investigated. A proposed model using three alert categories, graphically represented using three directions, probably combined with three severity levels is presented here. Up represents hypersensitivities, left/back represents alerting diagnosis and right/forward represents alerting current and planned treatments. A small qualitative user study of the alert classification model and some graphical representations of it was conducted. One main finding is that most respondents found the use of directions intuitive as a means of presenting categories. Context dependency, information overload, and future possibilities for automated alert-gathering are also discussed in the paper.

Keywords. Medical Warnings, EPR-CPR-EMR, Patient Safety, User-computer interface, Data acquisition- data capture, Graphical Representation

Background

To avoid exposure to known risk factors it is essential that important medical facts are put front and center. Lack of such information is a direct cause of injuries and even deaths in today’s health care [1]. Current directives from Sweden’s National Board of Health and Welfare require that certain important facts are presented highly visible [2]. Due to the fact that the regulation in particular is from the early 1980’s it is intended for paper-based health records. It says that information about hypersensitivity should be indicated on, for instance, the cover of the record’s folder with a red stamp or sticker.

During the last decades computers have been introduces as a tool in health record management. Trying to comply with legal standards suppliers of systems for electronic health records (EHRs) have implemented functionality in analogy with the cover stamps. Most common are icons using exclamation marks and triangles, often in colors like red, yellow and black [3]. The underlying data is still primarily related to drug hypersensitivity but may also give an opportunity to add other information that colleagues should know about. Research on alert indicators is hard to find on the international arena. Some parts of the work on VCM pictograms by Lamy et al [4] concern this area and may be applicable.

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In early 2007 a series of reports presented an information model for an “awareness signal” [5, 6]. The model was based on a broader definition than what is used in the present regulation. Among other things they mentioned current treatments and patient preferences, like declining to receive blood products and similar procedures.

Besides the extended definition a three-level scale of severity was introduced [5]. The most severe level is “life-threatening”. One step down is “harmful”, a condition bad enough to cause permanent and irreversible damage. The third one is “discomforting”, a non-lasting state that may lead to momentary or temporary issues. These levels are similar to the three used in some archetypes from openEHR, for instance the evaluation “Adverse reaction” [7]. In the openEHR setting the options for reaction severity are labeled “life-threatening”, “disabling” and “mild” respectively.

1. Material and methods

This paper seeks to present an initial visualization for an expanded definition of medical alerts and provide a first reaction from health care staffers. The main purpose has been to find a new standardized set of parameters for an awareness signal in the area of medicine. To narrow down the scope Swedish conditions have been our focus.

1.1. Expanded alert definition

Introducing an expanded set of parameters for medical alerts requires serious consideration. First of all the expansion must fit the clinicians’ needs. Secondly the parameters must be possible to clinically define and store in and retrieve from EHR systems. Finally there must be a way to present the data in relevant views to other clinicians. All of these criteria must be met in order to reach the fundamental requirement for a medical alert: the ability to show information that will prevent possible patient injuries; injuries that would occur if the alert was missing and standard procedures and treatments, harmless for most other patients, were used.

Starting with Carelink’s suggestions [5] for new alert parameters only a few made the final cut: hypersensitivity, current treatments and diagnoses. The use of the first one is already regulated and the two latter is added to widen the spectrum of information. Together these three include areas that need to be covered for more nuanced evaluations of the patient’s condition and treatment planning. Treatments can include everything from medications, which frequently give interactions, to implants—like pacemakers or surgical clips and staples—and similar prosthetics which are important to know about prior to some examinations, e.g. MRI scans. Diagnoses could embrace diseases resulting in a number of hypersensitivities, like malignant hyperthermia.

1.2. Visualization

In the prototype, shown below, the broadened set of alert parameters is encoded in a graphic representation. This symbol includes both the extended information and the

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2 http://www.openehr.org

3 Developed as part of a master thesis project at Linköping University, LiU-IMT/MI20-EX--07/457--SE (to be published spring of 2008).
severity levels and by using simple associations all new parameters is assigned a direction. The names of the parameters correspond to the directions according to:

- **Up: hypersensitivity**
  The Latin prefix *hyper-* translates to “over” or “above” as well as emphasizing increasing activity.

- **Left/backwards: important diagnoses**
  Clinical findings are made now or have been discovered earlier. Seeing the lower axis as a timeline, with the present at the center, puts diagnoses on the left side.

- **Right/forward: treatments**
  Current and planned treatments and other upcoming activities are set from now and into the future. Using the timeline metaphor these are put on the right side.

To indicate the severity of potential complications each direction is divided into segments to fit the three-leveled model. A short axis is equal to discomforting and a long is equal to life-threatening. This way the image seems larger the more severe the conditions are. The setup using perpendicular directions is meant to make complex information available in a structured and straightforward way. It shall give the user a first glimpse and an opportunity to later dig deeper into relevant areas. Even from a distance of a few meters away from the computer screen it gives a first impression of the situation. The colors are chosen to attract attention in contrast to the standard gray.

**Figure 1:** A sample symbol with three active alerts: one regarding a diagnosis, which due to some medications could cause a life-threatening situation (e.g. acute intermittent porphyria), one harmful hypersensitivity (e.g. gluten to coeliac disease) and one discomforting hypersensitivity (e.g. antibiotic causing significant diarrhea). The red border emphasizes a life-threatening warning and the center is used to indicate the patient’s sex.

Development and early evolution of the visualization were made with Bertin’s visual variables [8, section 4.3.1] in mind. Planar dimensions, size and colors are therefore the basic elements in the transition from structured data to visual object. Most of it is static, only colors lighting up the shapes when changing between the states. Using a grey outline for the inactive parts make it stay in place as well as, if empty, indicating that the alert system is implemented and running.

In order to get information about the single alerts there must be links between the symbol and the EHR notes. Using tool-tip functionality, like in many computer settings today, a short summary can be presented when the relevant area is hovered with the cursor. Taking yet another step the complete underlying note is retrieved.

It is important to point out that the alert does not have to indicate only incidents that already have happened. Issues that may occur also have an opportunity to be raised. The idea is to present the evaluation of future risks. Another crucial fact is that a gray symbol under no circumstances should be interpreted as if the patient can take any
treatment. Unknown or unrecorded problems may surface at any time. Empty symbols call for collection of information from other sources, perhaps from the patient herself.

1.3. Interviews

To make sure that a clinical perspective was present at all times, physicians have been consulted, interviewed and involved during all phases of development. For external feedback a short qualitative study involving six clinicians from diverging medical specialties was carried out. The interviews lasted 20-30 minutes and started with a short description of the project’s initial outcome including the graphical representation. After the brief introduction it continued with questions related to their present use of alerts. In the end they had an option to propose suggestions for further work. The interviewed physicians were working in areas from general practice and anesthesiology to emergency medicine, everyone with their own perspective on the subject.

After all interviews the material collected during the conversations was processed by two of the authors, who also performed the interviews.

2. Results

Due to the wide range of use cases in the health care environment a large study is needed to capture thoughts and ideas on a subject like this one. Because of the nature of this study—exploring a newly introduced concept—this initial inquiry was set as a small-scale study. For wider conclusions further interviews needs to be performed.

2.1. Discussing current use

Today’s stickers and stamps for alerts—on or off, no nuances—sometimes give misleading information according to the respondents. A sticker, which should indicate something important about the patient’s health, occasionally hints about personal preferences. On this the saying “Don’t cry wolf too often” repeatedly came up in the interviews, demonstrating the importance that the information is correct and up to date. You must be able to trust it; otherwise the alerts are disregarded in the long run.

2.2. Introducing the new ideas

Most of the respondents got the main idea, regarding separated categories and their assigned directions, from the introductory explanation. The associations made them aware of where the different parameters were positioned, which made some of them able to intuitively refer back to the directions later in the interview. On the other hand everybody did not find use for separating the information into different categories. One respondent, who had a background only using paper-based records, wanted a simple symbol to indicate potential alerts; a symbol which either was on or off.

The severity assessment was found to be a part many had opinions about. A couple of the respondents believed they would benefit from the risk levels and that it was easy

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4 Since this paper was first submitted, Nov. 18 2007, Carelink has published a report covering a more in-depth analysis regarding alerts. Available from: http://carelink.se/dokument/tillgang_till_vardinformation/nationell_patientoversikt/Rapport_Varning2_080208_ver_1.0.pdf
to estimate them, while others did not see the distinctions. Some concerns also arose regarding increased workload. Assessing and tagging risks was expected to increase administration, thus giving less time for patient care.

2.3. Suggestions from the respondents

A range of suggestions for improvements and additions came up. The emergency staff wanted an indicator for do not resuscitate orders. On the other hand, the primary health physician wanted to know about reduced cognition and need for an interpreter. Also, pregnancy came up as a suggestion. Some of the anesthesiologist proposed a more detailed graphical representation including the organ systems at risk.

Regarding display of patients’ personal preferences most of the respondents, upon being asked, found it improper. The situation may change the mind of the patient and friends, and family are usually rather quick to notify the care provider about preferences. Acting on old subjective information in an EHR may lead to wrong conclusions and an undesired outcome. The most common proposal was to add a warning for contagious blood, a wish relating to the staff’s own health and work environment.

A risk mentioned was information overload. Since some alerts only concern a small set of specialists—hypersensitivity to some anesthetic agents are only relevant to anesthesiologists—it might clutter the visualization for others to a point when facts are lost. A solution suggested was context control, so that irrelevant information is hidden.

Finally, it was pointed out that the EHR is only one of many tools. A dialogue between the patient and his or her physician is still an important source of information.

3. Discussion

The alert symbol shows a simplified version of the EHR content. It is a projection of relevant facts onto a pre-defined image outline. Making the most important record data easily available to the clinicians severe damages and deaths are hopefully prevented.

A new set of alerts categories must be comprehensive but minimalistic. In the same time, as many areas should be covered—seen from the suggestions the clinicians made in the interviews—it must be kept to areas that more than a few medical specialties are interested in and helped by. The latter is important because if you do not feel use for the work you put in, you are less likely to do it well. And medical alerts must be done right.

3.1. Interviews

From the interviews, it can be said that directions as information carriers is an area to keep investigating. How the respondents apprehended and learned the introduced concept from only a short presentation was notable. Using the associations from the categories’ names made the interpretation easy and in some cases intuitive, from the look of it. The important thing is that the symbol can be interpreted from a distance and give guidance in how to proceed; either to continue as always or stop to take in the new facts. Some of the proposals made by the respondents had good merit. The suggestion regarding contagious blood is important for everyone in touch with a health care establishment, staff or not. It is essential not spreading disease, especially when it comes to blood. In some form, this should be taken into consideration in future work.
Concerning the doubts on severity levels this needs further study. For whom is it important and for which parameters does it add value?

3.2. Automated alert gathering

A risk mentioned was increasing workload relating to assessing and adding new alerts. This could be addressed by computerized support. On a day-to-day basis diagnoses and treatments are documented, making most of the parameters already present in the EHR. Hypersensitivity is often related to chemical substances featured in the ATC classification and diagnoses are labeled with ICD-10 codes. Using these as base there are simple links between the three directions in the graphical representation and some easy to identify entities. Regarding treatments a combination of ATC and other classifications are suitable.

A mapping connecting the classifications to certain alert levels is one way to ease the burden. There are for instance lists of rare diseases [9] suitable for important alerts. How these pre-set alert levels are set is an issue for qualified medical personnel to sort out. Crucial to the automatic alert is to avoid false positives. Information given must be trustworthy. To assert the quality, the final assessment must be made by a human.

3.3. Closing comments

To conclude things we have found a demand and a wish for new alert categories, expanding the definition that today only include hypersensitivity. In addition the response to the visualization graphics, using directions to carry the data, felt positive and worth further exploring. This has already begun in a project by Carelink.

From the study we also found that in addition to alerts for the safety of the patients there is a need to alert the staff about risks they are exposed to, like contagious blood.

4. References


5 http://www.whocc.no/atcddd/