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## Usability of Three Graphical User Interfaces for Drug Allergy Documentation

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### Abstract

The current drug allergy documentation module in the electronic health record of our institution is in a free-text format. Two versions of a structured and coded drug allergy documentation module were developed. Twenty-five physicians tested the three interfaces via 3x5 test scenarios. The usability was measured for each interface with a system usability scale questionnaire. Both new versions scored significantly better than the current free-text version. User feedback will be used to further optimize the new module.

### Keywords:

Drug hypersensitivity, documentation, user-centered design

### Introduction

Availability of accurate and up-to-date drug allergy information is essential for clinicians to avoid severe or potentially life-threatening adverse drug reactions. Nonetheless, drug allergy information in electronic health records (EHRs) is often outdated and incomplete [1]. A major hindering factor is the electronic documentation itself: documented allergies can be found at numerous places in the EHR and the documentation modules do not lend themselves to efficient, complete and accurate allergy documentation [2]. In our institution, allergy documentation is in a free-text format, where the clinician fully decides how to characterize an allergy. This results in allergies most often only characterized by the culprit drug or drug class without any additional information. Because of the poor quality and the free-text format of drug allergy documentation, it is not possible to implement a clinical decision support (CDS) for drug allergy control as a tool to improve patient safety. An internal survey revealed that the clinicians themselves are not satisfied with the current way of documenting allergies and that it is not clear to them how they should document a drug allergy. A structured drug allergy documentation module could support the clinicians more in characterizing a drug allergy and at the same time enable the triggering of allergy alerts. Allergy experts agree that drug allergy information should be captured in coded terms and contain the following information: allergen, reaction, timing of onset, timing of initial reaction and diagnosis status [3, 4]. Next to the content and the coding scheme, the development of a good graphical user interface (GUI) is crucial for successful translation into clinical practice [5, 6]. Therefore, this study evaluated the usability of three graphical user interfaces for drug allergy documentation.

### Methods

Two new structured versions of the allergy documentation module were developed. The current GUI (GUI 0) and the two new GUIs (GUI 1 and GUI 2) were evaluated in a comparative usability study using a crossover design. Fundamentally, GUI 1 and GUI 2 are equal in that they ask about the same five information entries (product, reaction, onset, timing, diagnosis), but they differ in the way they ask this information. The second version (GUI 2) gives more support and guidance and is more specific than GUI 1. Participants were the end users of the allergy module, and thus physicians. They were sampled through a mix of purposeful sampling (maximum variation sampling) and snowball sampling so that they would represent several medical specialties and experience levels.

Each participant tested all 3 GUIs through means of fictional scenarios of patient allergy history taking. Per GUI there were 5 scenarios to complete, so in total each participant completed 15 scenarios. The participants always started with GUI 0 and were then randomized 1:1: to either proceed with GUI 1 followed by GUI 2 or to proceed with GUI 2 and then GUI 1 to control for a sequence effect.

The main quantitative outcome measure was the user satisfaction measured by the system usability scale (SUS) questionnaire. This is a standardized questionnaire consisting of 10 items to be scored on a 5-point Likert scale [7]. Each item's score ranges from 0 to 4. The sum of the scores is then multiplied by 2.5 to obtain the overall SUS value with a maximum score of 100. The participants completed such a SUS questionnaire after each set of 5 scenarios. To get more in-depth feedback, the researchers also directly asked about the positive and negative points of each GUI. These answers were particularly useful to pinpoint some specific problems the users encountered.

### Results

The twenty-five participants represented different medical specialties: 5 emergency physicians, 4 gynaecologists, 3 anesthesiologists, 3 geriatricians, 3 internal medicine specialists, 3 surgeons, 2 dermatologists, 1 pneumologist, and 1 radiologist. Thirteen participants (52%) were residents (i.e., physicians in training for specialization) and twelve (48%) were attending specialists. The median years of working experience was 6

years (range 0.5-20 years, interquartile range (IQR) 6 years). Only 4 participants (16%) reported to use the allergy documentation module often, while 17 (68%) reported to never or hardly ever use the allergy documentation module. These participants documented drug allergies in other places in the EHR, like for example in free text in their consultation report. Three participants (12%) indicated to be satisfied with the current allergy documentation module.

GUI 0 had a mean SUS score of 56, which translates to an adjective rating between OK and Good [7] (Table 1). GUIs 1 and 2 had a mean SUS score of 77 and 78, which translates to an adjective rating between Good and Excellent [7]. Because not all SUS scores were normally distributed and because it was a cross-over design, the Friedman test was used. The mean ranks were 1.36 (SUS 0), 2.20 (SUS 1), and 2.44 (SUS 2). The SUS scores were significantly different ( $p < 0.001$ ,  $\chi^2 17.106$ ). Then, three Wilcoxon signed rank tests were performed to compare 2 SUS scores at a time. SUS 0 was significantly different from SUS 1 and SUS 2 ( $p = 0.003$  and  $p = 0.001$  respectively), but there was no significant difference between the SUS scores from GUI 1 and GUI 2 ( $p = 0.383$ ).

**Table 1:** Descriptive statistics of the SUS scores for the three graphical user interfaces

	Mean (standard deviation)	Median (range, IQR)
SUS GUI 0	55.9 (16.98)	52.5 (20-87.5, 20)
SUS GUI 1	76.7 (12.30)	77.5 (45-95, 8.75)
SUS GUI 2	78.4 (9.46)	77.5 (57.5-97.5, 11.25)

All participants indicated that both new versions were much better than the current allergy module because it would lead to a more standardized and more detailed allergy documentation. All participants were positive about the five information entries, and especially about the option to document the diagnosis status of the allergy. Twenty participants (80%) had a clear preference for GUI 2 because it was more specific, 2 participants (8%) had a preference for GUI 1 because it was shorter and 3 participants (12%) thought GUI 1 and GUI 2 were equally good. Eight (32%) participants indicated that they felt confident while completing GUI 0, while this number increased to 20 participants (80%) for GUI 1 and 22 participants (88%) for GUI 2.

## Conclusions

Physicians score the usability of a structured and coded allergy documentation module asking five information entries (product, reaction, onset, timing, diagnosis status) significantly higher than the usability of a free-text allergy documentation module. They also feel more confident while completing the structured documentation module. User feedback will be used to develop a final new allergy documentation module.

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