

# Alerts for Low Creatinine Clearance: Design Strategies to Reduce Prescribing Errors

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## Introduction

Creatinine clearance is a common marker for kidney function and is regularly used to determine doses of medications that may be renally cleared or nephrotoxic. The use of alerts for creatinine clearance has been shown to reduce prescribing errors associated with renally dosed medications. However, the manner in which such information is presented can affect the usefulness of the alerts. *The objective of this study was to apply human factors principles to the design of creatinine clearance alerts. We hypothesized that the redesigned alerts which incorporated human factors principles would improve usability and reduce prescribing errors compared to an original alert design.*

## Methods

Twenty VA prescribers completed two 30-minute prescribing sessions for fictitious patients in a counter-balanced, crossover design. One session used the original alerts based on the VA's electronic health record system, and the other used the redesigned alerts. Each session involved three medications that required adjustment or cancellation due to reduced creatinine clearance: spironolactone, ibuprofen, and allopurinol. In the original design, the alert was presented prior to any medication selection, while the redesigned alerts appeared only after a renally dependent medication was selected and prescription information had been entered. The redesign also included additional details about potential risks to the patient. For usability, we analyzed video data and asked prescribers to rate the perceived efficiency of viewing related lab results; this item was analyzed with the Wilcoxon signed-rank test. Correct and incorrect actions for each medication were determined *a-priori* and were used to evaluate prescribing errors. We assessed prescribing errors using Wilcoxon signed-rank and McNemar tests. This study was part of a larger investigation that evaluated prescribing outcomes for various types of alerts. Previous literature has shown that 20 participants uncovers about 99% of usability issues for a given software design.

## Results

For usability, prescribers did not perceive any difference in the efficiency of viewing lab test results between the two designs ( $p=0.113$ ). However, 9 (45%) prescribers stated that they would ignore the original alerts because they were not in the process of ordering a renally cleared medication at the time the alert appeared. Participants made significantly fewer prescribing errors when using the redesigned alerts compared to the original alerts ( $n=26$  and  $n=47$ , respectively,  $p=0.001$ ). When using the original alerts, 15% of participants made only one prescribing error while 50% made an error for all three medications. However, with the redesigned alerts, 45% of participants made one error and only 1 (5%) participant made an error for all three medications. Prescribing errors were significantly reduced for ibuprofen and allopurinol with the redesigned alerts versus the original alerts ( $p=0.008$ ,  $p=0.012$ , respectively, for each medication). There was no significant difference in prescribing errors for spironolactone.

## Discussion

These results support the hypothesis that applying human factors principles to creatinine clearance alerts would reduce prescribing errors. Although others have noted that alerts should appear early in the prescribing process to reduce interruptions and support workflow, our results indicate that prescribing errors were reduced when alerts appear closer to the time of decision-making, in this case, later in the medication ordering process. Overall, incorporation of human factors principles into creatinine clearance alerts can reduce prescribing errors and thereby improve safety for patients with reduced renal function.