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# Faxed Arabic prescriptions: A medication error waiting to happen?

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## ABSTRACT

**Purpose:** The Arabic language uses notations called diacritical marks around characters to change which letter a symbol represents, changing the word in which that letter is contained. We explore the potential for error of these marks when faxed in a critical case such as prescriptions. A large number of patients are hurt by medical errors each year [1]. Extensive literature already documents the risks from handwritten prescriptions, while little work has been done with risks from reproduced printed prescriptions. No literature exists to examine risks of prescriptions in non-Roman character alphabets being reproduced. Reproduction via fax transmission is a common practice and often produces damaged copies which can lead to medication errors [2–4]. Languages with diacritical marks, particularly small ones, used for critical contextual meaning would more likely be at risk for misreading due to fax damage.

**Methods:** We generated text in English and Arabic reproducing common prescribing instructions, such as “every day” at various font sizes. This was placed on commonly used prescription paper, and reproduced via fax between 2 medical facility fax machines.

**Results:** We demonstrate meaningful change of prescribing instructions in the Arabic text by both the fax compression algorithm changing the appearance of diacritical marks along with a large amount of stochastic noise and dropouts being present. This change produced a potentially dangerous change in the instructions in the example we present.

**Conclusions:** Prescriptions that are faxed in languages that use diacritical marks to denote contextual meaning, are at high risk for misreading when reproduced via fax. We suggest mitigating strategies, including minimal font size and use of alliteration text in other languages.

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## 1. Introduction

The patient is involved in an early morning motor vehicle accident and is found sedated after using a scopolamine

patch prior to driving to work, which left him anticholinergic. When the accident is investigated, the prescription is found to have a transcription error from “every time on the boat” to “every day”; the remarkable part is that this was a computer

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**PENICILLIN G 1000000UNITS**  
**PENICILLIN VK**

**Fig. 1 – Readability of Roman serif fonts when half obscured.**

generated prescription which should be free of transcription errors normally associated with handwriting. The pharmacist may have had no reason to check the instructions as both “daily use” and “use while sailing” are reasonable prescribing instructions for this medication and yet, in this example, the difference clearly matters. While this may seem far fetched, we will demonstrate this exact example with faxed Arabic prescribing instructions. We will demonstrate the risk posed by faxing in non-Roman character based languages which are at high risk for medication errors despite computerization.

For as long as physicians have been writing prescriptions, medical errors have been generated by the misinterpretation of handwriting. While for hundreds of years, doctor’s handwriting was the bane of comedian’s jokes and cartoons, it came to the public’s attention in a serious way with the Institute of Medicine’s report *To Err is Human* in 1999 [1], which highlighted the high incidence of mortality from medical errors. From this report, and follow-on work, a large push has been made to switch over from handwritten to printed or electronic prescriptions and orders in both ambulatory and inpatient settings.

In settings where full provider-to-pharmacy electronic prescribing has not been implemented, the common practice is to print out a prescription and either hand the prescription to the patient or fax it to the pharmacy. This period of transmission is the most vulnerable, as the prescriber only has indirect contact with the pharmacist. We note that the safety of faxed prescribing has only been validated using Roman language fonts and even then has notable limits [2–4] as that is the language of the overwhelming majority of Computerized Physician Order Entry (CPOE) systems; we will demonstrate a simple but serious potential error in Arabic using the same method.

## 2. Background

Roman letters, are highly robust from damage in a low signal-to-noise environment such as faxing, while retaining readability. Sans serif fonts are not less readable [5] than serif fonts, but are more susceptible to damage related obfuscation. You can obscure almost half a serified letter and still maintain fairly good readability. In Fig. 1 we demonstrate this with a serified font where we see “PENICILLIN G 1000000UNITS” obscured from the bottom, which is still readable to a pharmacist. Even with the damage, you can tell which is Penicillin G and which is VK. This also works when the top half of the letters are obscured. It is true that you could not differentiate between Penicillin C and Penicillin G, but this is an extreme case to make the point, and no pharmacist would accept a prescription in which half the text had been lost; this robustness makes Roman letters quite safe to fax or use in low signal-to-noise printing to produce prescriptions.

كل يوم = Every Day  
 كل نوم = Every Sleep  
 كل بوم = Every Sailboat

**Fig. 2 – 3 dosing instructions in Arabic and English. The accents of the first letter of the second word is all that is different between them.**

Roman alphabets which use accent or diacritical marks, such as French and Spanish, may suffer subtle pronunciation deficits when accent marks are altered. However such changes to an accent mark almost never change the contextual meaning of a word to the point a reader would be fooled. In non-Roman languages such as Arabic this is not the case.

Arabic uses very small diacritical marks to denote which letter that form represents, which are essentially dots, which is also the noise pattern of transmission systems such as fax technology. Each primary letter form represents multiple letters with addition of the diacritical marks. In Arabic the ligatures and diacritical marks are critical to contextual understanding, and are quite susceptible to low signal-to-noise environments such as when prescriptions are faxed. Arabic is highly readable when printed clearly, however in a low signal-to-noise environment the diacritical marks are very susceptible to misreading, as the noise is similar to the marks themselves. To understand our fictitious example where the patient mistook a medication prescribed for boating with their daily medications, we present the following test case. In Fig. 2 we first demonstrate common Arabic text that might be used for prescribing instructions.

Note the main difference between these 3 phrases is the number and location of the diacritical marks (the dots) on the first letter of the second word. The letter form of this letter is identical between the phrases, but changes the letter it represents with the diacritical marks. In Fig. 2, the words in Arabic for every day (*Kol Yom* = Daily/Every Day), every sleep (*Kol Nom* = QHS) and every time on a boat in some Arabic dialects (*Kol Bom* = PRN sailing); the latter would apply for instance to scopolamine patches for motion sickness. These are very subtly different from a typographic sense: the leading *ya* of “*Kol Yom*” becomes a *nun* in “*Kol Nom*” with the moving of the 2 dots underneath to the superscript position. To change “*Kol Nom*” into “*Kol Bom*”, simply obscure one accent dot of the *ya* to make it a *ba*. The “every day” and “every sleep” were chosen, as those are very common instructions on medications.

The objective of this study is to highlight prescribing risks where electronic transmission artifact may significantly affect meaning.

## 3. Methods

To examine the effect of prescription faxing in Arabic, we used these three phrases which were printed in sizes from 9 point through 24 point onto tamper-proof paper. Tamper proof paper printed prescriptions are used when e-prescribing is not available at the target pharmacy. The paper includes visible fibers, watermarking and a security pattern. The resulting document

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