

Automated Recognition of Syringe Labels for Improved Patient Safety and Record Keeping: A Feasibility Study

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Although medical providers often recall error rates of less than 1%¹, studies have demonstrated that medication errors occurred with far greater frequency^{2,3}. Of note, nearly 50% of these errors are due to drug labelling errors or incorrect dosages of medication (23% and 24% respectively)². Many solutions have been suggested to decrease these errors, such as standard syringe placement⁴, a second person checking the provider's actions⁵, or barcode labelling and scanning (which may decrease error rates by 17%-41%^{2,6,7}). However, barcode scanning is an additional step which must be completed prior to drug administration in order to potentially prevent medication errors.

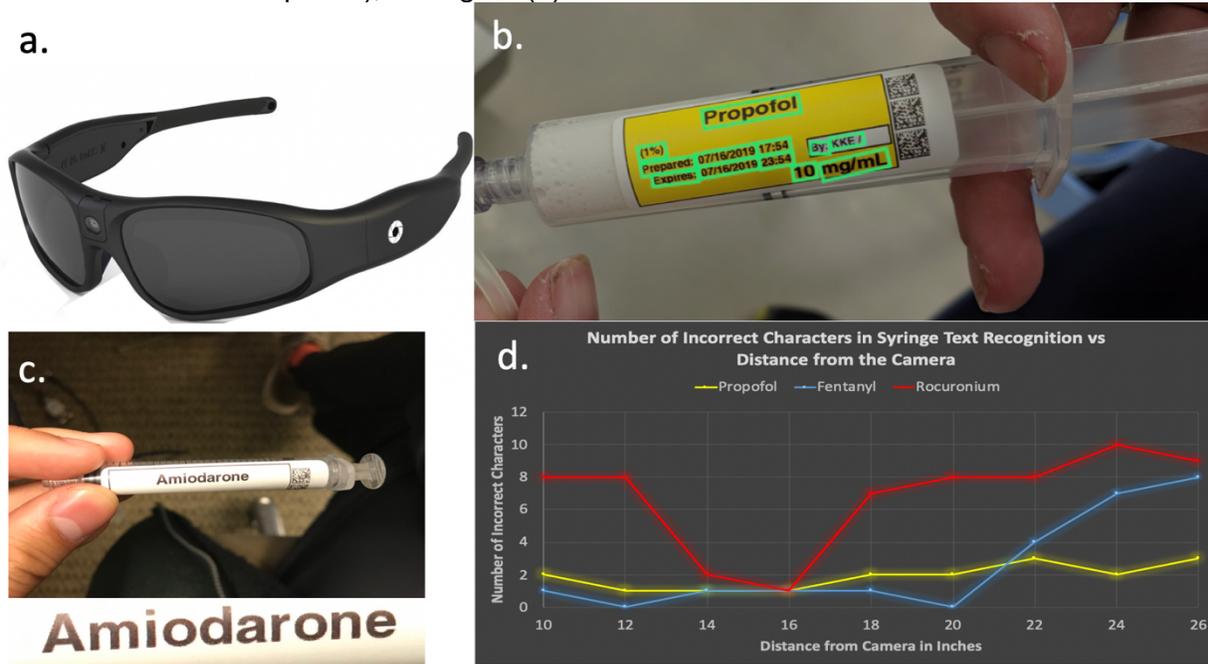
An ideal solution would provide auditory or visual feedback anytime a syringe is picked up by the anesthesia provider and automatically record drug delivery in the medical record. Recent advances in smart eyewear combined with automated visual detection algorithms could seamlessly integrate into the operating room workflow. This new technology would leverage that crucial short window of time between selection of a syringe and drug administration to provide real time feedback to prevent drug errors and also document drug delivery in real time. This initial feasibility study was performed to assess the capabilities of existing hardware and software and understand the technological advances necessary before bringing such a product to market. Open source code repositories from academic research groups and eyewear with embedded video and photo recording capabilities, shown in the figure (a), were used for this study. Two distinct steps need to occur in order to identify syringe text labels. The first step is recognition of text within the image, highlighting different groups of text using bounding boxes. The second step is optical character recognition, inferring the actual text characters contained within the bounding boxes.

Initial testing involved up close photograph of four syringes labeled with the Codonics® syringe labels. A more systematic review of the effects of distance was then performed. A continuous video of three empty syringes with the labels of propofol, fentanyl and rocuronium from a distance of 42" to 4" were taken as well as photographs of the labels across the same distance taken at 2" intervals.

Initial testing on promising models that perform both text recognition and character recognition yielded unacceptable results with text outputs unrecognizable from the original words. Running separate algorithms for text recognition and optical character recognition with some manual processing led to better performance.

CRAFT: Character Region Awareness for Text Detection⁸ is an excellent tool for creating bounding boxes around the text, as shown in the figure (b). At distances up to 26", a bounding box surrounding exactly the word fentanyl on a fentanyl syringe was created in all cases. The character recognition program that yielded the best results was MORAN: A Multi-Object Rectified Attention Network for Scene Text Recognition⁹. Initial tests on full images yielded unrecognizable results for a series of four syringes. However, manually cropping these images to include only the text, as shown in the figure (c), led to correct identification of every drug. Hence, this algorithm is robust for optical character recognition after some preprocessing, which could be automated using the CRAFT algorithm described above. For the analysis syringes at

various distances, Propofol and fentanyl syringes could be identified up to 20" from the camera, with a maximum of two letters different from the actual text (tentanyl or propolot, for example, were considered acceptable), see figure (d).



In conclusion, using existing software tools, it is possible to identify syringe text from photographs taken on an eyeglass mounted camera up to 20" away with only slight errors. However, there are no commercial or prepackaged algorithms with all the essential features for syringe text recognition at this time. It is necessary to modify existing algorithms to obtain a bounding box around text on a syringe and then run character recognition algorithms. Further improvements, such as limiting word choices to a set of common anesthetic drugs may improve the robustness of such software techniques.

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