Hypothesis

A Natural Language Understanding (NLU) algorithm can identify potential transcription errors during dictation by highlighting them in near real-time utilizing an estimate of a level of ‘confidence’ for a given word or phrase and this can improve accuracy and efficiency of reporting.

Purpose

Radiology in the current era is transitioning to provide maximum value to the patient, as directed by the ACR’s imaging 3.0 initiative which focuses on imaging appropriateness, quality, safety, efficiency, and satisfaction [2]. This represents a paradigm shift in radiology, which is now geared towards maximizing value to the patient. The paradigm shift requires 3 elements: new ideas, new data and information, and a new culture [3]. Since the advent of electronic medical records, a vast body of information is readily available at the clinician’s fingertips. The radiology text report is another potential area for information extraction and analysis.

Currently, natural language processing software has not been widely applied for standardized analysis of radiology reports to assess their efficacy. The lack of systematic analysis of these reports has consequently made it difficult to determine how effective the radiology report is at conveying important information. In one study, radiologists manually analyzed 265 reports for errors, and they found significant errors in 59 (22%) of these reports [4]. The process of reporting currently requires manual proofreading of text reports at the end of a dictation to identify any missed errors. The same study also surveyed 88 radiologists about how often they believe their reports contain errors, and the majority responded less than 10% [4]. Other studies found error rates in final reports ranging anywhere from 2-13% [5-10]. Such high error rates force radiologists to carefully proofread each report before finalizing. Even with proofreading, a significant number of reports could still potentially contain errors. Dictation errors include wrong-word substitution, nonsense phrases, and missing words that could ultimately lead to confusion to the ordering physician. Given the pace at which many radiologists work in the current era, proofreading becomes a cumbersome and oftentimes arduous process. New technologies are being developed to parse through text documents to identify and tag each individual word and phrase. Natural understanding algorithms can be used to enhance the reporting process, streamline proofreading, and create an interactive environment to decrease the likelihood of submitting a report with dictation errors.

Natural Language Understanding (NLU) technology has tremendous potential to acquire and systematize data from radiology reports with the goal of tracking specific trends and/or parameters to improve their quality. Natural language processing (NLP) has become a routine part of everyday life, from popular search engines to e-mail filters and is now penetrating the medical field [11]. NLU is a subset of NLP, which tries to tackle the problem of taking completely unstructured inputs without formal rules and convert them into a formal structure that a computer algorithm can interpret. These technologies also open the possibility of analyzing a large volume of data, as shown in one study which tested an algorithm on more than 4,000,000 reports for trends[12]. Given the variability in the styles of reporting by each radiologist, and the infinite clinical possibilities in any given report, an NLU algorithm needs more than a semantic “understanding” of terms and concepts. This study focuses on using this
technology to evaluate text reports with potential dictation errors in real time by providing varying levels of confidence with visual feedback.

**Materials/Methods Used**

A random assortment of 100 radiology previously generated text reports including most modalities were re-dictated using speech recognition software into a test environment to evaluate an NLU algorithm. During the dictation of previously read and de-identified studies, terms which have a low level of confidence by the NLU are highlighted in a color depending on the level of confidence, which is then displayed on the screen in real time. The human testers dictated in two different speeds to determine the performance of the algorithm. Each report was dictated at a normal pace, and again at twice the normal pace. The highlighted terms were cross referenced with the actual report that was being dictated to determine whether the NLU was able to identify any words/phrases that could potentially be errors. First, the dictated report was compared to the original report to see if the transcription was successful. Secondly, the human testers calculated the number of differences and the fraction of those differences that were highlighted by the NLU as having low confidence in both normal and fast pacing.

**Results**

The NLU algorithm was tasked with identifying words which were recognized to be of low ‘confidence’ such as those used infrequently or that seemed to be out of context and displayed to the radiologist by highlighting the word or phrase in a given color corresponding to the level of confidence. The threshold for highlighting a word or phrase could be adjusted. The confidence threshold for highlighting words or phrases could be adjusted to various levels including anything less than 100%, to less than 20% certainty. With decreased errors in dictation, referring clinicians will have increased confidence for the information contained within the report which may lead to more effective decision making and improved patient care.

**Discussion**

The standard process of manual proofreading prior to submitting a finalized report is time consuming and has been shown to be ineffective in completely eliminating errors from the report. Even after proofreading, reports have errors ranging from 2-13% based on previously mentioned studies [5-10]. This is an area that requires more awareness and attention, and may also require a novel approach to solve. The actual impact of the errors on patient outcomes is unknown, but one can anticipate decreased confidence in the information within the radiology report if it is fraught with significant errors.

One potential solution is to use NLU technology to help radiologists dictate their reports by giving them feedback in real time for potential errors. This proactive approach can save time and reduce the difficulty and angst associated with manual proofreading, especially in a large volume of text. This process is interactive with visual feedback given to words or phrases that have particularly low confidence by the NLU algorithm.

There are many plausible reasons for dictation errors persisting even after proofreading. One of which has to do with the motivation of a radiologist. If his/her goal is to have a rapid turnover of finalized reports, then there may be insufficient motivation to take the time to carefully read through each report before finalizing. This is because suboptimal reports might be perceived as not leading to any direct consequence to the radiologist. Another potential reason is speed of dictation. In 2006-2007, the annual relative value units (RVUs) per full-time equivalent (FTE) radiologist increased by 70% when compared with 1991-1992[13]. This tremendous increase in volume of radiology reports can directly impact dictation speed. One pilot study found a positive correlation between faster dictation and significant dictation and interpretation errors [14] as would be intuitively expected.
Conclusions

New advances in natural language processing software and digital storage capabilities can facilitate efficient analysis of large volume of data. Currently radiology reports are largely unstructured and have a large amount of information but can be analyzed by NLU technologies. Without assistance from such software, there is a high degree of reliance on the radiologist for accurate dictation and proofreading. This type of manual proofreading has been shown to not be fully effective in eliminating errors. These errors can be reduced substantially by using newly available technology to help the radiologist with real time proofreading.

References


Keywords

natural language understanding, NLU, communication, natural language processing, NLP, clarity