Web-Based Orthopedic Personalized Predictive Tools

Web-based personalized predictive tools in orthopedic surgery are becoming more widely available. Despite rising numbers of these tools, many orthopedic surgeons may not know what tools are available, how these tools were developed, and how they can be utilized. The aim of this scoping review is to compile and synthesize the profile of existing web-based orthopedic tools. We conducted two separate PubMed searches—one a broad search and the second a more targeted one involving high impact journals—with the aim of comprehensively identifying all existing tools. These articles were then screened for functional tool URLs, methods regarding the tool's creation, and general inputs and outputs required for the tool to function. We identified 57 articles, which yielded 31 unique web-based tools. These tools involved various orthopedic conditions (e.g., fractures, osteoarthritis, musculoskeletal neoplasias); interventions (e.g., fracture fixation, total joint arthroplasty); outcomes (e.g., mortality, clinical outcomes).

1. Introduction

The ability to provide personalized predictions of clinical outcomes in the field of orthopedics is gaining interest [1][2][3][4][5]. Databases encompassing robust and accurate patient-level data [6][7][8], greater access to patient information via the electronic medical record [9], and the rise of advanced analytical capabilities, such as machine learning [10][11], provide the prospect of great strides in both our understanding of musculoskeletal problems and the outcomes of orthopedic interventions. Unlike simple risk calculations, web-based predictive tools analyze larger amounts of patient data and utilize algorithmic mathematical modeling and prediction analytics using advanced computing.

Despite the technological advances in predictive tools, many challenges exist in practical implementation of these solutions in clinical settings. Firstly, there is no common repository or standardized location to access personal predictive tools. These tools span various subspecialties within the field of orthopedics and other surgical specialties (e.g., capable of providing general risk calculations). As a result, where to find and identify tools appropriate for their clinical needs remains a barrier for orthopedic surgeons in practice. Secondly, once a tool has been identified for use, it can be difficult to discern how the tool was developed (i.e., what data inputs have been used to define the tool's algorithm) and how it has been assessed for technical feasibility and validated (i.e., the extent to which a tool can be used in a practice setting to fit a given need). Our overarching goal was to perform a scoping review to comprehensively map and organize the knowledge base around web-based personalized predictive tools in orthopedics.

2. Discussion

In this scoping review, we systematically identified 31 web-based tools designed to provide personalized prediction in various of orthopedic settings. Overall, these tools provide orthopedic surgeons with information supporting the outcome prediction of fractures, mortality, other clinical events, such as surgical complications, and miscellaneous clinical processes, such as length of stay. This information applies to settings in different orthopedic subspecialties, in various points of the clinical pathway including pre- and post-operative surgical planning, and for shared decision-making with patients in discussions of elective surgeries.

2.1. Limitations

This work should be considered in light of some limitations. Firstly, many identified papers had tools that were inaccessible or had broken URLs. While this may indicate that a given tool was discontinued for technical reasons, it is challenging to ascertain whether there were modifications made for a newer version or alternative use. As tools continue to develop, iterative processes with well-documented updates and modifications will need to be utilized to better implement these tools in clinical practice. Secondly, papers presented varying levels of detail regarding the tool development process which limited standardization of specific parameters. Future work should aim to increase

transparency in the tool development and validation processes so that tool comparisons are uniform and systematic. Thirdly, only one database was used to search for these tools. While this raises the possibility of missed tools, the two searches conducted for this study were broad and anticipated the capture of the vast majority of these web-based orthopedic solutions. The selected electronic database (PubMed) is also the most relevant to clinical orthopedic practice. Finally, there may be more tools in development that are currently being validated at various institutions and remain unpublished at the time of this review. While this is largely unavoidable in a fast-paced field, further work may target the grey literature and other types of electronic databases or search engines to capture such tools.

It is difficult to quantify the current use of web-based orthopedic predictive tools in practice. This scoping review demonstrates a rapid increase in the frequency of tool-related publications over the last two decades, perhaps reflecting growing interest in web-based orthopedic predictive tools. Although specialized commercial software packages may overshadow the use of web-based tools in areas such as pre-operative planning, web-based tools offer additional and unique functions, such as patient and surgical outcome predictions. In this way, web-based tools serve as potential complements to already established software packages.

Identified tools consistently rely on more established statistical methods for their development, such as multivariate analysis and logistic regression. There were only two tools that demonstrate the use of machine-learning algorithms in their development, both of which were released within the past 5 years. Artificial intelligence and machine learning have the ability to process large amounts of data in different forms, including actively and passively generated data from patients. It is likely that, as this technology evolves, future web-based medical tools will make increasing use of advanced predictive analytics and provide greater opportunities for more personalized patient care.

2.2. Future Work

The profile of tools identified in this study indicate two major areas for potential improvement. First, fewer than half of identified tools utilize patient-reported inputs. This may be related to the reliability of obtaining information from patients, as these data require active procurement in prospective cohorts or may not be consistently documented for retrospective cohorts. Despite these barriers, patient reported measures are important components of patient outcomes and ensure physician focus on subjective metrics that patients care about, such as perceived pain. As patient-reported outcome measures are increasingly used in both the field of orthopedics and across medical specialties, greater incorporation of patient-reported data into these tools presents an area of potential improvement. Second, tools identified in this study fall into just a few orthopedic categories, such as fractures, total joint arthroplasty, spine, and oncology. These categories may reflect a lack of tools for other orthopedic subspecialties, such as orthopedic sports injuries. This lack may be related to the heterogeneity of injuries in such fields or insufficient access to large existing patient databases for tool development. Continued expansion in the development of tools across orthopedic subspecialties would afford a wider breadth of resources to orthopedic surgeons to better clinical outcomes for patients and should be a focus of improvement.

3. Conclusions

The increasing number of web-based orthopedic tools is an opportunity for orthopedic surgeons to better predict outcomes and increase understanding of expectations with patients. The aim of this scoping review was to identify the current list of web-based orthopedic tools, as well as clearly outline their utility and validation.

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