Computer-based Medical Algorithms: Overview and Experiences

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Introduction: An algorithm is a step-by-step recipe, guaranteed to terminate, for performing a specific task. Medical algorithms are computational encapsulations of medical knowledge. Computer-based medical algorithms can potentially be powerful tools to enhance medical care. In this paper we provide an overview of the range and scope of medical algorithms as well as potential benefits from their usage in medical care. Some of these include reduced errors, task automation with cost containment, standardized care, quality management, and improved documentation.

*Types of Medical Algorithms:*Johnson *et al* [1] identified the following 16 types of medical algorithms.

1. Coding & look-up tables
2. Comparison with normal population standards
3. Data conversion
4. Decision rules & triaging
5. Decision trees & flow diagrams
6. Diagnostic criteria
7. Diaries & symptom tracking
8. Functional state description
9. Grading and scaling
10. Probability & statistical analysis
11. Prognostic scores
12. Questionnaires
13. Risk determination
14. Simple classification
15. Simple formulas
16. Therapeutic indications and contraindications

In contrast to clinical guidelines, which are typically brittle, hard to validate, and not easily customizable or transportable, published medical algorithms are robust, modular, can be combined sequentially or in parallel to aid in complex decision making, and are typically supported by clinical studies in the peer-reviewed biomedical literature.

Potential Benefits of Medical Algorithms: Properly conceived and developed, medical algorithms can replace subjective judgments with objective decisions validated over an appropriately matched patient population. For example, in anesthesiology, scoring systems for predicting difficult tracheal intubations [2] have been devised based on measurements of cephalometric features. Widespread use of such algorithms, rather than subjective evaluation, can promote standardization and automation of anesthesiology administration. This, in turn, can result in decreased medical errors, reduce costs and improve documentation and efficiency of practice. Conversely, failure to use an algorithm can result in errors, since practitioners may not use all clinically relevant information or they may reach erroneous conclusions, especially when under work or time pressures [1]. When implemented on a computer, medical algorithms can deliver results in seconds, freeing the practitioner to focus more on patient care.

The benefits of medical algorithms can be fully realized only when algorithms interoperate with electronic health record systems and are available to the practitioner at the point of care. This eliminates the need for tedious data entry, enables up-to-the minute documentation, and provides the opportunity for clinical alerts. However, creating such a resource is not straightforward. Executable forms of possibly thousands of medical algorithms have to be encoded and embedded in a distributed computing framework that can query the appropriate health and laboratory

information systems. The front end of such a resource must be able to decide automatically, possibly using heuristic tools and ontologies, the applicability of potentially relevant algorithms to the patient in question. Such applicability is modulated by patient age, ethnicity, gender, comorbidities and other factors. Internet-based technologies, due to their flexibility, support for distributed computing, and ability to inter-operate across heterogeneous environments, appear to be most appropriate for this purpose.

MedAL: The Medical Algorithms Project: A free web-based resource, the Medical Algorithms Project (www.medal.org) has existed since 1998. It was created for the express purpose of disseminating medical algorithms in computer-executable form, the vast majority of which were hitherto available only in paper-based media. The latest version (16.0) contains over 8,000 algorithms covering 45 medical specialties, and is visited by over 1,000 users every weekday. Free registration was introduced in September, 2004, and as of Aug 29, 2005, there have been 19,685 registered users from over 180 countries. See the Figure for a breakdown by profession. MedAL includes a Spanish language subset. All of the algorithms can be executed online as MS Excel spreadsheets. The ultimate goal is to convert all to web-based forms.

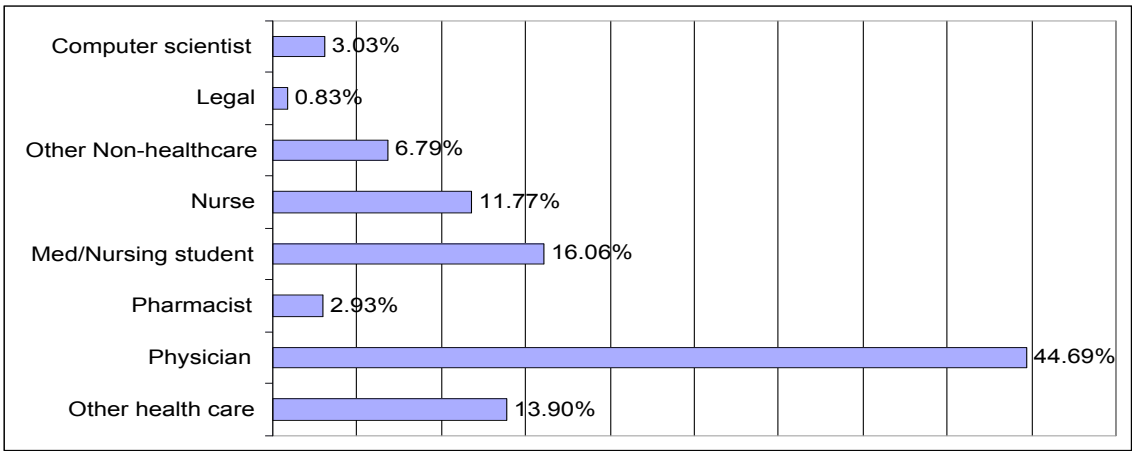

Figure: Registered users by profession as of August 29, 2005. Total, 19,685

References

[1] Johnson, KA, Svirbely, JR, Sriram, MG. Automated Medical Algorithms: Issues for Medical errors. AMIA 2001.

[2] Nath G, Sekar M. Predicting difficult intubation - A comprehensive scoring system. Anaesth Intens Care. 1997; 25: 482-486