Establishing the Need for Artificial Intelligence Applications in Clinical Pathology Microscopy Based Tests

ARUP LABORATORIES
An enterprise of the University of Utah and its Department of Pathology

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Abstract

Background: Artificial intelligence (AI) based tools can improve the interpretation accuracy, precision and reproducibility of microscopy slides. As innovations in digital pathology applications are becoming more accepted in anatomic pathology clinical use, the adoption of AI and digital microscopy based testing in clinical pathology is lagging behind. There are several reasons including the lack of resources, expertise and an obvious return on investment (ROI).
Clinical pathology testing is highly complex and variable, requiring extensive resources for diagnostic-test development. The ROI for development of low-priced clinical pathology tests is not as immediately evident as other high-revenue microscopy-based tests.
The lack of commercially available AI based tools for our clinical pathology microscopy tests and our interest in developing these tests initiated a feasibility study to prioritize internal test development.
Methods: Analysis of operational and financial metrics for microscopy based tests performed at ARUP during the period of July 2019-June 2019.
Results: Candidate tests for machine learning augmentation were identified based on financial feasibility studies and the operational needs of ARUP. Metrics included cost of labor, test volume, market demand, and impact on patient care.
Hypothesis: Classical microscopy based reference lab tests are in need of AI augmentation. ROI can be established given their high volume and relative labor expense.

Introduction

ARUP Laboratories is a national clinical and anatomic pathology reference laboratory, offering more than 3,000 tests and test combinations. More than 10% of the tests require the use a microscope for some or all of the testing protocol.
The development of AI augmented microscopy testing in clinical pathology is currently less prevalent than tissue based pathology. The lack of resources, expertise and obvious ROI contribute to the lack of available AI tools in clinical labs.
An AI-augmented ova and parasite detection tool for stool test was recently developed and integrated at ARUP's clinical lab. There is now an effort to develop additional custom AI augmented testing to address some of the challenges diagnostic labs are currently facing (Fig. 1)

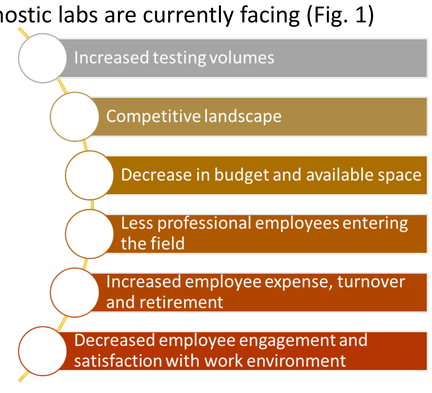

Fig 1: Trends in current clinical laboratory industry

Investment in AI based tools can help address the current and anticipated future shortage of laboratory technologists and pathologists by replacing some of the labor-intensive mundane tasks, enhancing clinical test capacity, and improving quality and patient care (Fig. 2).

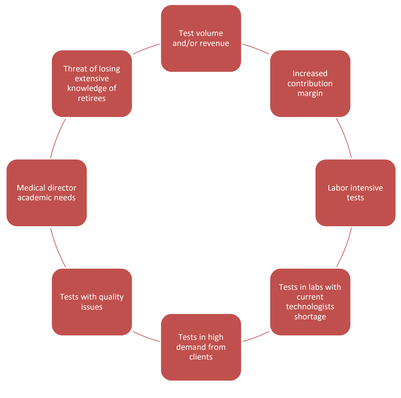

Fig 2: ARUP's AI augmented microscopy test development considerations

Considerations for determining investment in future test development must include various operational and financial metrics to determine the feasibility and potential ROI.

Materials and Methods

Data mining and analysis were performed on multiple operational and financial databases at ARUP. Data presented is for the period of July 2018-June 2019. No patient data was used in this study.

Results

Distribution of Microscopy Based Tests

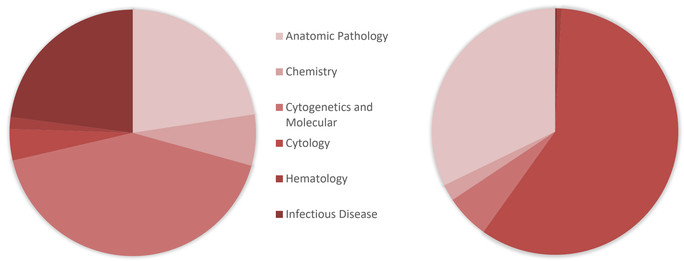

Fig 3: Relative distribution of ARUP's microscopy test menu revenue (left) and volume (right) for different clinical divisions.

ARUP's test menu has over 300 microscopy based tests. These tests are performed in 30 labs that are grouped into 6 divisions. When analyzing the revenue and volume of these divisions, significant but anticipated differences are found between the anatomic pathology revenue and volume and those of the other divisions (Fig. 3).
The top 20 revenue generating tests contain representatives from 5 divisions: Anatomic Pathology, Chemistry, Cytogenetics and Molecular, Hematology, and Infectious Disease (Fig 4).

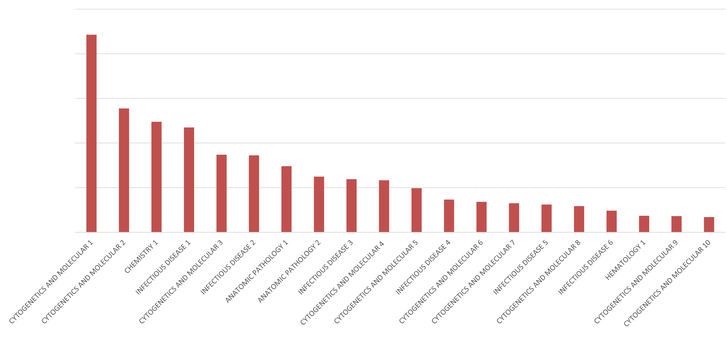

Fig 4: Relative test revenue of ARUP's top 20 microscopy tests

The top 20 high volume microscopy tests contain representatives from the same 5 divisions as the revenue generating tests : Anatomic Pathology, Chemistry, Cytogenetics and Molecular, Hematology, and Infectious Disease (Fig 5). This reinforces the potential for AI based assay improvements chemistry and infectious disease labs.

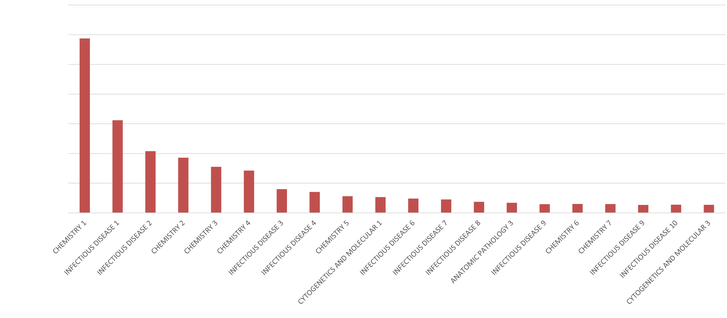

Fig 5: Relative test volume of ARUP's top 20 microscopy tests

Labor Expense

One of the great advantages of augmenting classic microscopy tests with AI is the reduction of time a highly trained technologist and/or pathologist needs tp spend doing routine tasks. A growing shortage in technologists and pathologists means more competition for competent individuals and a higher recruitment cost for laboratories as well as a higher turnover rate for experienced individuals. HR data and future projection for technologist shortage can be found in Fig. 6.

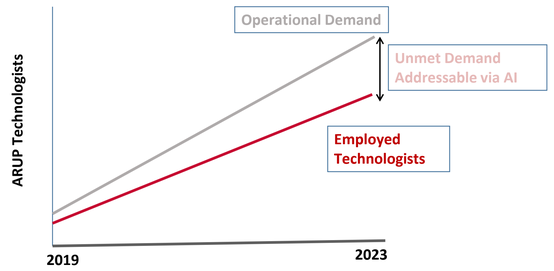

Fig 6: Technologist shortage at ARUP and potential for AI augmented tests.

The ARUP microscopy test menu was evaluated for labor costs for both technologist and pathologist time, and anticipated differences were found for the tests in the different divisions (Fig. 7). The data was corrected for the different priced tests by comparing the percent of the labor cost to the total cost of the test. The labor cost is a major component of many test costs, and further study is warranted on the tests with the highest labor expense contribution.

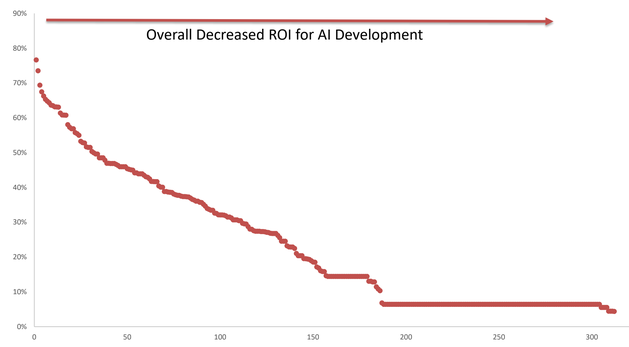

Fig 7: Total labor expense as % of test cost for ARUP's microscopy tests

Additional collected data included the contribution margin of the tests, test complexity, and market demand. Specific considerations for the performing lab such as employee turnover, time needed for training, existing and future infrastructure were also noted. These metrics, along with an estimated cost of developing AI tools were used to establish ROI projections to guide decision making and development. The patient care impact and academic productivity potential were also factored into the priority list for our laboratory needs.

Conclusions

The diagnostic lab industry has been undergoing many changes in recent years. An increase in newly insured patients and growth of an aging population result in more demand for diagnostic tests than ever before. There are more commercial targeted therapies, more available technologies and more biomarkers analyzed, all in an increasingly competitive landscape. There is also a decrease in reimbursement, lab budgets, space, and time that can be allocated to develop tests. At the same time, there is an increasing shortage of highly skilled technologists and pathologists which is anticipated to grow in future years.
AI based microscopy tests can help labs improve their productivity and competitiveness while increasing capacity and driving down costs, resulting in increased efficiency and ability to respond to the price pressures of the competitive diagnostic testing market and healthcare expense containment. For labs facing technologist shortage, it is essential to develop AI capabilities to maintain their operations standards.
While most development of AI based microscopy tools targets the anatomic pathology market, labs can also identify and focus on developing AI based tools for their internal clinical pathology test needs. With limited available resources, a careful study of test metrics is required to justify investments in development and to determine ROI for new AI based tools.

Acknowledgements

This work was supported by the ARUP Institute for Clinical and Experimental Pathology.