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Future Scanning: Medical Laboratory and Lab Information Systems (LIS)

As defined by the National Center for Biotechnology Information (NCBI), the medical/clinical laboratory is a healthcare facility responsible for performing various tests on biological specimens collected from patients, and aiding the physicians in carrying out diagnosis, treatment, and management of patients (Bayot & Naidoo 2019). Medical laboratories have been a part of the healthcare system for centuries, in one way or another dating back to 300-400 BC. Between the 300BC and the late 17th century many different practices arose.
From Hippocrates who promoted the use of mind and senses as diagnostic tools to Galen (180 AD) who is recognized as the founder of experimental physiology, to Anthanasius Kircher, Robert Hooke and Marcello Malpighi who were amongst the pioneering microscopists through the 16th into the 17th century (Berger). Most of the laboratory related observations to this point were based on the patient's urine. During the late 17th century an English physiologist was working on experiments with blood transfusion, body temperature, and pulse rate (Berger).

Eighteenth century marked a very successful period for healthcare advances as well as a medical laboratory. One of the most notable advances in the eighteenth century was the discovery of the cause of coagulation which would lead to the measurement of prothrombin time (PT/INR), PTT, and other coagulation tests (Berger). By the mid-nineteenth century, another wave of diagnostic tools including the microscope, the X-ray, the spirometer, and the electrocardiogram. Such technologies allowed for the laboratory work to be done away from the patient and allowed physicians to collaborate and evaluate the results as the team (Berger).

The beginning of the twentieth century marked the beginning of a quality movement in the healthcare industry. The medical laboratories were finally getting respect and recognition. Additionally, professional organizations emerged to provide the knowledge and skills to laboratory professionals and lobby for legislation on the behalf of laboratories. During the initial third of the century, most of the advances made were helpful in determining the causes of different illnesses but not necessarily finding the cures. It was not until 1930, when Beckman Instruments was founded, that laboratories had an actual instrument to run the testing (Park, Pantanowitz, Sharma, & Parwani 2012). From that point on, different analyzers were introduced along with refrigeration units, freezers, centrifuges, as well as newer methodologies.

Even with the ability to perform automated or semi-automated testing, the laboratory technicians were still paper-bound and had to record their findings by hand. The concept of laboratory information system (LIS) was first introduced in the 1960s by a Bolt Beranek Newman company in Massachusetts when they partnered up with the Massachusetts General Hospital to build a software system capable of managing data across multi-user platform (Park, Pantanowitz, Sharma, & Parwani 2012). However, it was not until the 1980s and the advances of Structured Query Language (SQL) and Health Level 7 that allowed software developers to expand the

functionality and interoperability of the LIS (Park, Pantanowitz, Sharma, & Parwani 2012). The SQL and the HL7 remain the golden standard for LIS development and advances.

At the present time, there are dozens of LIS companies out in the market. Some are comprehensive and all inclusive, others are modular or restricted to only pathology or only clinical. Overall, the majority market share belongs to a handful of well-known companies that have been in business for 20 - 30 years, such as McKesson, Cerner, Allscripts, Orchard Soft, Siemens, and GE Healthcare (Aller & Weiner 2019). For Laboratories that are searching for an LIS, it can become very difficult to compare and evaluate all the options out there; however, it is imperative to perform the do diligence to find the best fit.
The general medical laboratory market today is mostly monopolized by the hospital-owned labs, and two/three conglomerates such as Quest Diagnostics, LabCorp, and ARUP. The rest of the market is shared by a large number of smaller, customer-oriented, specialized, local laboratories. Such laboratories have a hard time competing with the conglomerates and often have to select one or more of them as a reference laboratory.

Speaking from experience, and having evaluated numerous LIS systems out there as a healthcare IT consultant, I noticed that most LISs come with a lot of bells and whistles that smaller laboratories may never use, but would be paying for. Having an option to customize the features to tailor your needs is very attractive and mostly found with the smaller companies that are modular. Regardless of the system, the initial cost of setup, training, and integrations could be very high and could cripple organizations, especially if they are not growing in volume and reducing costs in order to generate more revenue. With that in mind, the phenomenon of hiring outside consultants to evaluate, negotiate, and customize the system is growing amongst the smaller laboratories that may not have the funds to staff an internal LIS management team.

The future of medical laboratory information systems is going to revolve around customized reporting, ability to add new features and modules to accomodate for new testing that comes out to the market such as molecular and DNA sequencing, and the Artificial Intelligence or Augmented Reality integrations to evaluate the lab results and guide the laboratory technicians and medical directors in making the right diagnosis, especially in the hospital setting (Newitt 2019).
Furthermore, as the population continues to increase in age over the next five years, it is expected that the number of individuals over the age of eighty will increase by ten percent (Markin & Whalen 2020). According to the healthcare trends mentioned in the article, it’s not just the population of aging citizens, but also the changes in the diseases amongst the given population that is changing accordingly. Rheumatologic diseases, neurological diseases and autoimmune diseases are expected to rise by a significant percentage (Markin & Whalen 2020). Additionally, in the area of Pathology, the interest in three-dimensional imaging and scanning and three-dimensional reconstruction is rapidly growing (Panteghini 2004). A notion that a certain analyzer would be able to scan and analyze a two-dimensional slide and the cells on it into a three-dimensional image to be stored inside of the LIS or have the LIS create a

three-dimensional reconstruction of a certain carcinoma from a series of two-dimensional images is soon to become a reality (Panteghini 2004).

According to The Clinical Biochemist Reviews article, in addition to diagnostic problems, clinical laboratories are now increasingly becoming involved in assisting physicians to make therapeutic decisions. In order to do so AI and Data Analytics will play a crucial role along with the laboratory scientists who have knowledge in a diverse group of medical specialties and organisational and leadership skills (Panteghini 2004). Lastly, having a direct interface with the clinicians, hospitals, insurance carriers, health exchange hubs, whether local or interstate will be a must to take the laboratory information system to the next level. For healthcare information technology consultants this should be a golden opportunity. With an increased demand for lab-related technological advances, the need for technicians who can implement ad support it, will also be in demand. According to the projected job outlook reported by the US Bureau of Labor Statistics, from 2018 to 2028, the healthcare consultants will certainly be in high demand. The job outlook is expected to be between 14% to 18% which is much faster than average (USBLS 2019).

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