Chapter XI
Computer Assisted Cervical Cytology

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ABSTRACT

Automation and emerging information technologies are being adopted by cytology laboratories around the world to augment Pap test screening and improve diagnostic accuracy. Informatics, the application of computers and information systems to information management, is therefore essential for the successful operation of the cytopathology laboratory. This chapter describes how laboratory information management systems can be used to achieve an automated and seamless workflow process. The utilization of software, electronic databases and spreadsheets to perform necessary quality control measures will be discussed. The emerging role of computer assisted screening and application of digital imaging to the field of cervical cytology will be described, including telecytology and virtual microscopy. Finally, this chapter will reflect on the impact of online cytology resources and the emerging role of digital image cytometry.

INTRODUCTION

The Papanicolaou test (Pap test) is a highly successful, widely used, and cost effective method for the early detection of cervical dysplasia and cancer. However, Pap tests are not infallible, and emerging technologies have been developed to help improve diagnostic accuracy. Moreover, the shortage of skilled cytotechnologists to screen and diagnose Pap slides has become a concern, thus

driving the goal to develop automated laboratory instruments and screening systems (Kumar and Jain, 2004). There are several steps that occur between obtaining a Pap test from a patient to the issuing of a diagnosis in the form of a useful and timely cytopathology report. These include specimen labeling and tracking, receipt of patient material in the cytology laboratory, accessioning of the specimen along with pertinent patient and clinical information into the laboratory computer system, specimen processing involving instrumentation, the possible performance of special studies, interpretation of prepared material (e.g. slides) by cytotechnologists and cytopathologists, and finally the creation and delivery of an accurate and understandable pathology report.

Laboratory informatics, the application of computers and information systems to information management in the pathology laboratory, is an essential component of this entire process (Pantanowitz, Henricks & Beckwith, 2007). Providing information in a manner that is most effective for patient care is the primary mission of the cytology laboratory. In addition, data from the cytology laboratory is used for documentation of quality control (QC) measures and quality assurance (QA), performance improvement, outcomes studies, and research (Raab et al., 1996; Becich, Gilbertson & Gupta, 2004). Despite the overwhelming interest in the development of several computer based technologies in the last several years, the role of automation in cytology has remained controversial (Masood, Cajulis, Cibas, Wilbur & Bedrossian, 1998). Much of this stems from laboratories not knowing how to incorporate automation in the routine practice of cytology. Around a decade ago, only 12% of cytology laboratories surveyed in the United States were engaged in automated cytology, and they predominantly used it for quality control (QC) measures (Masood et al., 1998). Today, with reduced costs and increased education, there is wider acceptance of these technologies in many different countries, particularly with regard to

computer assisted cervical screening (Richards et al., 2007; Palcic, Sun & Wang, 2007).

The aim of this chapter is to demonstrate how cytology laboratories processing, screening, interpreting, and reporting out Pap tests have capitalized on the availability of computers, information systems and digital imaging to ensure quality enhancement, improved productivity, and thereby improved patient care.

LABORATORY INFORMATION SYSTEMS

The laboratory information system (LIS) is the core of many cytology laboratory operations. Its functions include workflow management, specimen tracking, data entry and reporting, assistance with regulatory compliance, code capture, interfacing with other systems, archiving, inventory control, and providing billing information (Pantanowitz et al., 2007; Eleveitch & Spackman, 2001; Cowan, 2005). Components of the LIS include hardware (e.g. servers), peripherals (e.g. instruments, printers), a network, interfaces (hardware and software links) to automated instruments and other information systems (e.g. electronic medical record and financial systems), database(s), and software such as an operating system, database management system, and specific applications required for laboratory operations. The LIS is often leveraged to improve efficiency, enhance productivity, reduce staff needs, facilitate automation (e.g. interface with automatic sample preparation, staining and slide cover slipping machines), and eliminate potential sources of error. The LIS also functions as a database that determines the configuration of system parameters and stores patient-related data (**Figure 1**).

The LIS database provides a flexible and organized way to store, retrieve, and manipulate data to ultimately generate usable information. LIS dictionaries and worksheets define the conventions and logical framework for information

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