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TRAINING OF PATHOLOGY LABORATORY TECHNICIANS-A SYSTEMATIC REVIEW

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ABSTRACT: *The purpose of this paper is to present a systematic review of the training of technicians in pathology laboratories, as well as the current level of pathology technicians in the world. This paper follows the structure of the PRISMA model with slight modifications. The findings of the review indicate that recent developments such as increased application of molecular biology in pathology, ICT advancement, increased need for quality assurance, and the emergence of other important skills are some of the key factors influencing changes in the required skills and competencies for pathology technicians. These required skills and competencies are similar in all countries. However, there is a lower availability of skilled and competent pathology technicians than is needed. Among other impacts, this issue has contributed to an increased number of errors in pathology laboratories during recent years, and to the inability to implement new technology in the laboratories.*

KEYWORDS: Pathology, Systematic Review, Laboratories, Training,

INTRODUCTION

Various changes that have taken place in the pathology industry over the last decade have led to significant changes in the required skills for pathology technicians. A pathology technician is a person who works in a pathology laboratory under the supervision and direction of a qualified pathologist. A pathology technician is qualified to carry out various autopsy and surgical tasks. One of the major roles of a pathology technician is to prepare specimens and chemicals needed during pathology testing. Other functions of a pathology technician include the procurement of samples and chemicals, research, training other technicians when needed, and to perform other assigned duties such as teaching and supervisory, budgetary and administrative tasks (Rodrigues et al., 2013). Although they are not expected to carry out diagnostic tests, pathology technicians play a significant role in pathology laboratories and so influence the quality and quantity of diagnostic tests. As such, they are expected to have adequate skills and competencies to carry out their assigned duties efficiently and effectively.

For more than one and half centuries, there has been constant development in the field of pathology driven by new discoveries, among other factors. At the same time, there has been a constant rise in the demand for quality health care, which is also influenced by the quality of output from pathology laboratories. In order to enhance the quality of output from pathology laboratories,

agencies within and outside the profession have, for a long time, set standards for eligibility in the profession. However, rapid changes have taken place during the 21st century that have had a drastic impact on the skills and competencies needed in the profession. As a result of these changes, the demand for a higher level of skills and competences among pathology technicians has increased. The issue has influenced many accreditation agencies to revise the minimum requirements for entry into the profession. Despite this intervention, the gap between the skills available and the skills required has been increasing (Rodrigues et al., 2013). The purpose of this paper is to answer the following question; How are the improve the quality of skills for Pathology technicians?

METHODOLOGY

Protocol

A plan for carrying out the research, and the inclusion criteria are outlined in the protocol.

Inclusion and exclusion Criterion

The following table presents a summary of the criteria that was used to include and exclude studies.

Table 1.0 Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Only studies that were written in English were included	Studies written in other languages other than English were excluded
Studies published within the last ten years were included	Studies that are older than ten years were excluded
Studies that are relevant to the current topic of study were included	Studies that are not relevant to the current topic were excluded
Studies that did not have significant levels of biases were included	Studies with significant levels of biases were excluded
	Studies that involved literature reviews only were excluded

The research methodology used for this study included analyzing journal articles published within the last ten years that contain studies with topics relevant to the current research objectives. The studies included were selected randomly. The studies were found to be appropriate in explaining recent changes in the skills and competencies of pathology technicians since they are based on recent, authoritative data.

Studies were identified through scanning a reference list related to the research topic in the BibMe database. The references identified were then searched in the Medline database, the Google search engine and the Cochrane Library database. Direct searches were also carried out in the Medline database and the Google search engine. The last such search was carried out on 22 July, 2014.

The table below presents the terms that were used to search the relevant sources in the databases search engine;

Table 2.0 Search terms

Search terms
Pathology technician
Pathology technicians skills/ training
Recent changes/ trends in pathology technician skills and competencies
Recent development in pathology technician skills and competencies

Study Selection
The researchers involved independent reviewers to assist in the process of screening and determining eligible studies for inclusion in the review process. In case of any disagreement, the reviewers engaged in close evaluation of the content of the studies.

Data collection process
The researchers adopted a theoretical approach in extracting the data required for the study. The first reviewer collected data, and the second reviewer checked it. Any disagreement was solved by a third reviewer.

Data Items
Information was extracted from each source depending on its relevance to a specific research objective.

Risk of Bias in Studies
In order to identify biases in the studies, the reviewers worked together in evaluating the suitability research designs used and data collection methods and procedures and the validity and reliability of the data collection instruments.

Planned Analysis Methods
The researchers applied content analysis method of the content of the studies in order to extract the useful information related to the study topic.

Risk of Bias across Studies
The cumulative evidence of the studies reviewed may result into biases resulting from factors such as selective reporting and publication bias.

RESULTS

Study Selection
A total of 103 studies were identified for inclusion in the review from searches of the BibMe, PubMed and Medline databases, the Google search engine, and the Cochrane Library database. However, some contained information that was repeated in other studies. After removing them, only 69 studies remained. The remaining studies were screened, and 33 were excluded due to lack of adequate information that would contribute significantly to the current study. The details contained in the remaining 36 studies were assessed for eligibility. A further 14 studies did not meet the inclusion criteria due to the presence of bias. The biases found included design bias, procedural bias, sampling biases and reporting bias. Only 22 studies were, therefore, included in

the systematic review since they contained information that was relevant to the current study, and they did not feature common biases. Figure 1.0 in the Appendix gives a summary of the study selection process while the table below summarizes the characteristics of the studies selected:

Table 3.0 Summary of the characteristics of the studies included

Author	Study type	Purpose	The relevant information present
Adyanthaya and Jose (2013)	Review	To evaluate the quality management systems guiding the quality of output from pathology laboratories in the US and UK.	Factors leading to changes in the demand for pathology technicians' skills and competencies.
Alaamern (2012)	Review	To explore the level of training of staff employed in the radiography field in Saudi Arabia.	The training level for laboratory staff, including technicians.
Bashawri, (**2006**)	Questionnaire	To analyse the profile of medical laboratory technologists working in the major hospitals of eastern Saudi Arabia, including personal data as well as career patterns.	The current level of pathology technicians' skills and competencies
Bahaadinbeigy, Yogesan and Wootton (2010)	Survey	Investigating the level of application and effectiveness of telemedicine in Australia.	Advancement in the use of telemedicine technology in pathology.
Buesa (2010)	Mixed Methods	Productivity quality in histopathology laboratories is lower than expected.	The current level of pathology technicians' skills and competencies.
Colebourn, Davies and Becher (2010)	Analysis of case study	Investigating the gap in training for clinical laboratory workers and suggesting ways of bridging the gap.	The current level of pathology technicians' skills and competencies.
Daniel et al. (2011)	Database Analysis	Investigating the applicability of standard digital equipment that produces digital images in pathology laboratories.	Factors leading to changes in the demand for pathology technicians' skills and competencies
El-Mahalli, El-Khafif and Al-Qahtani (2012)	Questionnaire	Investigating challenges and successes in the application and implementation of telemedicine in Saudi Arabia.	The laboratory technician training challenges are affecting the implementation and application of telemedicine.
Ezziane et al. (2012)	Content review	Evaluating ways of enhancing the performance and effectiveness of healthcare workers.	Factors leading to changes in the demand for pathology technicians' skills and competencies.

Flynn et al. (2014)	Viewpoint	The extent to which laboratory staff receive training in the use of molecular biology in diagnosis.	Lack of adequate training of pathology technicians in the use of molecular biology in their work.
Hammerling (2012)	Review	Reviewing the errors occurring in clinical laboratories and their causes.	The impact of inadequate skills and competencies.
Hawash (2014)	Research Article	Evaluation of an algorithm based on immunoassay for identification and screening of Cryptosporidium and Giardia antigens in faecal specimens.	Increased application of molecular biology technology in the pathology profession.
Lippi, Plebani and Šimundić (2010)	Review	Investigating the extent to which theory on quality enhancement is applied in laboratory diagnostics.	Factors leading to changes in the demand for pathology technicians' skills and competencies.
Morelli et al. (2013)	Pilot Study	Investigating the root causes of errors in histology laboratories.	The role of lack of adequate training of pathology technicians in the increasing number of laboratory errors.
Nichols (2011)	Review	Reviewing the effectiveness of quality control approaches applied in order to reduce the risk of low-quality results in clinical laboratories in Saudi Arabia.	The role of quality control in clinical laboratories.
Oosterhuis And Zerah (2014)	Review	Investigating the gap in training for clinical laboratory workers and suggesting ways of bridging the gap in European Union	The current level of technicians' skills and competencies and the quality System.
Rodrigues et al. (2013)	Review	Examining the application of molecular biology in the diagnosis of prostate cancer.	Factors leading to changes in the demand for pathology technicians' skills and competencies, and the impact of inadequate skills and competencies.
Saikia, Gupta and Saikia (2008)	Commentary	Evaluating trends in modern histopathology.	Factors leading to changes in the demand for pathology technicians' skills and competencies.
Salari (2009)	Review	Investigating disparities between required and available skills and competencies of medical professionals dealing with personalized care.	The current level of pathology technicians' skills and competencies.

Walz (2013)	Review	To examine the required training and education for medical laboratory professionals in the US.	The required skills and competencies of pathology technicians.
Yorukoglu et al (2011)	Questionnaire	To examine the required training and education for medical laboratory professionals and Pathology Laboratories Productivity Evaluation in Turkey.	The required skills and competencies of pathology technicians.
Zima (2010)	Review	To examine the accreditation standards for pathology laboratory staff in different countries.	The required skills and competencies of pathology technicians.

SUMMARY OF FINDINGS

Recent changes which impact on skills and competencies

The studies examined have pointed out various changes that have occurred in the pathology profession over the last decade. According to Rodrigues et al. (2013), pathology technicians are increasingly faced with work challenges that did not exist for previous generations. Some of these challenges have a direct impact on the necessary skills and competencies for pathology technicians. One of the major changes examined by the studies is the increased application of molecular science in diagnosis. According to Hawash (2014) pathology has moved on from its initial central focus on autopsies to an increased focus on molecular biology. Examples of this change include the application of molecular science in the immunotherapy for cancers and the classification of traditional histology (Rodrigues et al., 2013; Hawash, 2014)). According ng to Flynn et al. (2014), pathology professionals seem to be exploring areas that earlier generations could not have imagined. With the increased application of molecular biology and biotechnology in diagnosis, individuals working in pathology laboratories are expected to be well versed with its application, in addition to the traditional pathology testing techniques. Although pathology technicians are not required to have the ability to conduct complex tests, they are required to be well acquainted with the new methods of preparing samples and the instruments used in molecular tests.

According to Saikia et al. (2008), advancement in information communication technology (ICT) has also had a major impact on the work of pathology technicians. Telemedicine, a concept that was unheard of only a few years ago, is one of the main applications of ICT in pathology. Telemedicine involves the exchange of information about patient care from one point to another through electronic means in order to improve the quality of care. One of the key sub-disciplines of telemedicine is telepathology, which involves “capturing, transmitting, and viewing histological and pathological images through telecommunication channels such as telephone, dedicated satellite or internet, as opposed to the traditional methods of microscopy” (Saikia et al., 2008). According to Daniel et al. (2011), advancement in technology has led to the emergence of

telepathology systems that enable pathologists to accurately exchange such information, and hence to deliver quick and accurate diagnoses. Daniel et al. (2011) explained that the emergence of virtual slides has led to the increased significance of telepathology in pathology laboratories. A virtual slide refers to a digitized image that emerges after scanning a specimen at a very high resolution. According to Saikia et al (2008), the virtual slide enables pathologists to derive an image at all of the magnifications or fields of view that a microscope has. The images derived from the different views are stitched together into a single image that multiple pathologists can view at the same time. A useful example of this is the ultra-rapid virtual slide processor (Saikia et al., 2008).

Further, the studies reviewed have shown that an increased demand for quality assurance over recent years has led to significant changes in the skills and competencies needed for pathology technicians. Today, legislation has become strict, and an incorrect diagnosis may lead to punitive punishment for pathology professionals. There are national agencies that constantly inspect the quality of pathology laboratory output. In the UK, inspection is carried out by the Care Quality Commission, among other organizations. In the US, quality is regulated by agencies such as the College of American Pathologists and the National Accrediting Agency for Clinical Laboratory Sciences (Adyanthaya & Jose, 2013). In Saudi Arabia, quality in pathology laboratories is inspected by the Central Board for Accreditation of Health Institutions (Alkhenizan & Shaw, 2011). At the international level, quality is regulated by organizations such as World Health Organization and the National Standard and Regulatory Agencies (Adyanthaya & Jose, 2013). Lippi et al (2010) noted that additional pressure is exerted by the general public, as people are increasingly demanding better quality health care services. As such, there has been an increase in pressure on persons working in pathology laboratories to be accountable for the quality of their work. As members of the pathology laboratory team, pathology technicians are also accountable for their actions.

According to Ezziane et al. (2012), organizations, including pathology laboratories, have become aware of the fact that they are increasingly operating in constantly changing internal and external environments. In some cases, the changes are unpredictable and may have huge effects on the performance and quality of output. In some cases, the changes may involve uncertainties that may have unfavorable effects on an organization. An illustrative example of this is the recent shortage in the number of skilled pathology technicians available in countries such as the UK and the US. This staffing problem has contributed to the work overload experienced by many pathology technicians in these two countries during recent years (Ezziane et al., 2012). In order to counter such unfavorable effects, it has become imperative for pathology laboratory managers to implement proactive strategies to enhance the quality and speed of reaction to both predictable and unpredictable changes. As such, skills that would enhance such strategies in organizations have become very important, although they are not directly related to the basic skills needed in the profession. Skills that have become important for this reason include team working, communication, decision-making and critical-thinking skills (Ezziane et al., 2012).

With the changes observed by various scholars in the pathology field, it has become important for the accreditation of all individuals working in pathology laboratories, including laboratory technicians, to be reviewed upwards. In addition, re-accreditation of all the individuals working in laboratories has become very important (Ezziane et al., 2012).

The Skills and Competencies Required of Pathology Technicians

The results of recent studies have shown that the increased need to achieve quality results and to incorporate high-complexity testing in pathology laboratories has raised the demand for pathology technicians with higher levels of skills and competencies. As a result of this demand, the skills and competencies needed for pathology technicians in many countries have been reviewed upwards. As noted in the studies reviewed, the required skills for the profession in the UK, US, Canada, Saudi Arabia, Australia and other countries are similar (Walz, 2013; Nichols, 2011). One of the most important basic skills noted in the studies is the ability to carry out biological and chemical tests. Additionally, pathology technicians are expected to have the ability to apply safety, mathematical and mechanical knowledge to their work (Zima, 2010). Other important skills mentioned in the studies are active listening, writing, verbal problem solving, critical thinking, reading comprehension, quality control, decision-making, monitoring, operation and control, time management, equipment and systems maintenance, coordination, service orientation, systems evaluation, and interactional skills. With an increased application of computer technology in the pathology profession, technicians are also required to have up-to-date computer skills (Walz, 2013). Among the most important competencies examined in the studies are attention to detail, cooperation with fellow workers, dependability, integrity, stress tolerance, self-control, independence, achievement, and persistence.

The impact of inadequate skills and competences

The studies reviewed have shown that the lack of adequate skills and competencies has a major impact on the pathology technician profession. To start with, the problem has contributed to an increased number of errors occurring in pathology laboratories. In fact, studies have cited this problem as the major cause of pre-analytic, analytic and post-analytic errors occurring in pathology laboratories (Hammerling, 2012; Morelli et al. 2013). Secondly, the problem has contributed to the inability of pathology laboratories to implement new technologies. For instance, many pathology laboratories have experienced difficulties in implementing molecular biology and automation programs due to a lack of adequate knowledge and skills among staff. A study conducted by El-Mahalli et al. (2012) found the lack of adequate training on the part of technicians and other pathology laboratory staff to be a hindrance to the successful implementation of telemedicine. Bahaadinbeigy (2010) found similar results in Australia.

SUMMARY

In summary, the studies reviewed identified various recent developments that have had an impact on pathology technicians' skills and competencies. The developments identified are the increased application of molecular biology in pathology, ICT advancement, the increased need for quality assurance, and the emergence of other important skills. The studies have also identified various skills and competencies needed by pathology technicians today. Despite the rise in entry requirements for the field, there are unfortunately still a limited number of available skilled and competent pathology technicians. This problem has contributed to an increased number of errors in pathology laboratories, as well as to the inability to implement new technology.

To the researchers' knowledge, no studies have been conducted in Saudi Arabia in recent years that focus on the role and training of laboratory technicians in pathology laboratories. Further, no advanced studies have been carried out to assess laboratory technicians' use of quality control in pathology laboratories in Saudi Arabia.

CONCLUSION AND RECOMMENDATIONS

In conclusion, there is an increasing need for skilled and competent pathology technicians, but this need is not currently being met. Intensive training of new and existing pathology technicians is required in order to bridge the knowledge gap. This can only be achieved if issues such as the lack of funding for training programs, and the lack of incentives to provide additional training to existing pathology technicians are addressed.

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10.0 Appendix

Figure 1.0: A summary of the study selection process