CHAPTER 1
EMERGING FRONTIERS IN BIOMEDICAL DIAGNOSTICS

Mariaulpa Sahalan and Siti Aisyah Mualif

1.1 INTRODUCTION

This book offers an in-depth understanding of current methods for detecting body tissues and physiological functions, which are crucial for medical diagnosis and rehabilitation programmes. It also explores the latest research on these detection methods. Specifically, the book examines three types of body tissues: Pectoral muscle, brown adipose tissue (BAT), and wounds. In addition, it discusses two physiological functions: Breathing patterns and cardiorespiratory exercise.

The pectoral muscle, located beneath the breast tissue, supports the breast and is crucial for breast cancer assessment. The is a type of adipose tissue that generates heat by burning calories, helping to regulate body temperature, and is primarily located in the supraclavicular region, the mediastinum, the axilla, the paravertebral areas, and around the heart and kidneys. A wound is an injury to living tissue, typically involving a break in the skin or other body membranes. Monitoring wounds is important because it helps guarantee proper healing, prevent infections, and detect any complications early. Breathing patterns refer to the rhythm and rate of breathing, impacting health and stress levels. Cardiorespiratory exercise includes activities like walking, jogging, and swimming that improve heart and lung efficiency.

In rehabilitation, optimising breathing patterns and cardiorespiratory exercise significantly helps patients recover from respiratory conditions, reduce stress, and improve overall functional capacity.

Detection of the pectoral muscle significantly affects early-stage breast cancer assessment. Similarly, detecting BAT is crucial for assessing metabolic diseases such as diabetes mellitus, hypertension, and obesity. Furthermore, monitoring wounds at different healing stages is essential for identifying chronic wounds, which take longer to heal compared to the normal recovery phase. In addition, assessing the breathing patterns of cardiovascular patients are important for post-surgery monitoring and rehabilitation programmes. Moreover, evaluating breathing patterns during cardiovascular exercise or dedicated rehabilitation programmes helps improve patients' independent breathing after surgery in a shorter period.

There is extensive research around the world with the aim to cure the diseases, but most of the medical experts agree that prevention is better than cure. To prevent the disease, we need to change our lifestyle, but experts also agree that detection of disease at an early stage certainly brings more advantages to the patients as well as the caregiver. Thus, many researchers remain interested in studies for early disease detection to improve our healthcare management. Furthermore, rehabilitation has been proven to improve patient recovery significantly along with consistent disease treatment. Thus, the research on breathing patterns as well as cardiovascular exercise will help us tailor unique rehabilitation programmes with the ability to accelerate the recovery process for patients.

This chapter begins with a review of advanced detection methods in biomedical diagnostics, covering the pectoral muscle in Section 1.2, brown adipose tissue in Section 1.3, wound monitoring in Section 1.4, breathing patterns in Section 1.5, and cardiorespiratory exercise in Section 1.6

1.2 PECTORAL MUSCLE

Breast cancer is one of the most prevalent cancers affecting women globally, and early detection plays a critical role in improving survival

rates. Mammography, a specialised X-ray imaging technique, is currently the most effective tool for early detection, capable of identifying abnormalities before physical symptoms develop. Timely diagnosis through regular screenings allows for less aggressive treatments and significantly reduces mortality rates. A study on 549,091 women in Sweden emphasises that early mammography screening can decrease breast cancer mortality by up to 40% (Duffy et al., 2020).

Mammography is essential for early breast cancer detection due to its efficiency, affordability, and low radiation exposure. Radiologists depend on clear images and correct breast positioning to find early signs of cancer. If the breast is not positioned correctly, it can lead to missed diagnoses and higher costs (Karnati, 2021). Standard mammography includes craniocaudal (CC) and mediolateral oblique (MLO) views, which are crucial for comprehensive imaging, though visualising the pectoral muscle in the MLO view can be challenging (Gilbert & Pinker-Domenig, 2019; Karnati, 2021).

Manual assessment of the pectoral muscle by radiologists is a time-consuming process. Deep learning algorithms, particularly convolutional neural networks (CNNs), have shown high success rates in tasks like image classification, segmentation, and object detection (Gupta et al., 2021; Karnati, 2021). Various models, including U-Net, holistically edge detection (HED), RetinaNet, DeepLabv3+, and SegNet, have been employed to segment the pectoral muscle in mammograms. A recent study demonstrated that the integration of DeepLabv3+ with ResNet-18, ResNet-50, SegNet, and U-Net CNN models markedly enhanced the precision of pectoral muscle segmentation from MLO projections of mammography (Zhou et al., 2022). However, previous studies have not utilised these segmentation results to measure the width and length of the segmented pectoral muscle in assessing breast images.

1.3 BROWN ADIPOSE TISSUE

Brown adipose tissue (BAT) has recently been found to exist and work in adults, which makes it important in addressing obesity and related