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DEVELOPING A NOVEL BIOMARKER FOR EARLY DETECTION OF BREAST CANCER

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Abstract
Finding reliable biomarkers from a conveniently accessible source is therefore essential as it could result in reasonably priced assays that are useful for routine screening. An alternative, non-invasive method of improving cancer screening may be offered via blood-based indicators. Many important studies on the creation of screening tools utilizing blood-based biomarkers have surfaced in recent years, despite the fact that none of the biomarkers now available on the market are sensitive enough for the early detection of BC.Blood-based biomarkers for BC screening are still in their infancy, nevertheless, and several preclinical and clinical issues need to be addressed before they can be used in clinical settings. The most current studies on the application of blood-based biomarkers as innovative BC screening methods are compiled in this review, along with the restrictions and difficulties that must be resolved before their application is moved from the bench to the bedside.
Keywords: blood-based, great potential, latest discoveries, clinically

1. INTRODUCTION

Because individuals with breast cancer (BC) who are discovered early have a much better prognosis, screening for BC is important for improving patient outcomes [10]. Currently the gold standard and primary tool for BC screening, mammography has a number of well-known problems, such as a high rate of false positives and overdiagnosis, as well as a poor ability to detect cancer [1]. Early identification greatly increases the survival and cure rates of breast cancer. Though its accuracy and effectiveness have long been questioned, as has its inability to detect small lesions, especially in women with dense breast tissue, mammograms are commonly used to detect breast cancer early [2]. Therefore, there is an unmet clinical need to address the limitations of mammography by offering a quick and simple diagnos [11]. Treatment for breast cancer depends on an accurate and timely diagnosis [4]. Even though mammograms are frequently used for breast cancer screening, worries about the radiation from these tests as well as the high rates of false-positive and false-negative results have persisted for a while [8]. The development of "omics" techniques over the past 20 years has greatly expanded the quest for non-invasive biomarkers for early breast cancer diagnosis[3]. In this review, we give a summary of the current status of various areas of study[16]. But for many years, there has been a contentious international discussion about the advantages and disadvantages of mammography [12].

2. REVIEW OF LITERATURE

Therefore, other methods are essential for breast cancer early diagnosis. When the tumors are benign, a surgical or needle biopsy is usually performed to confirm the diagnosis of breast cancer[5].

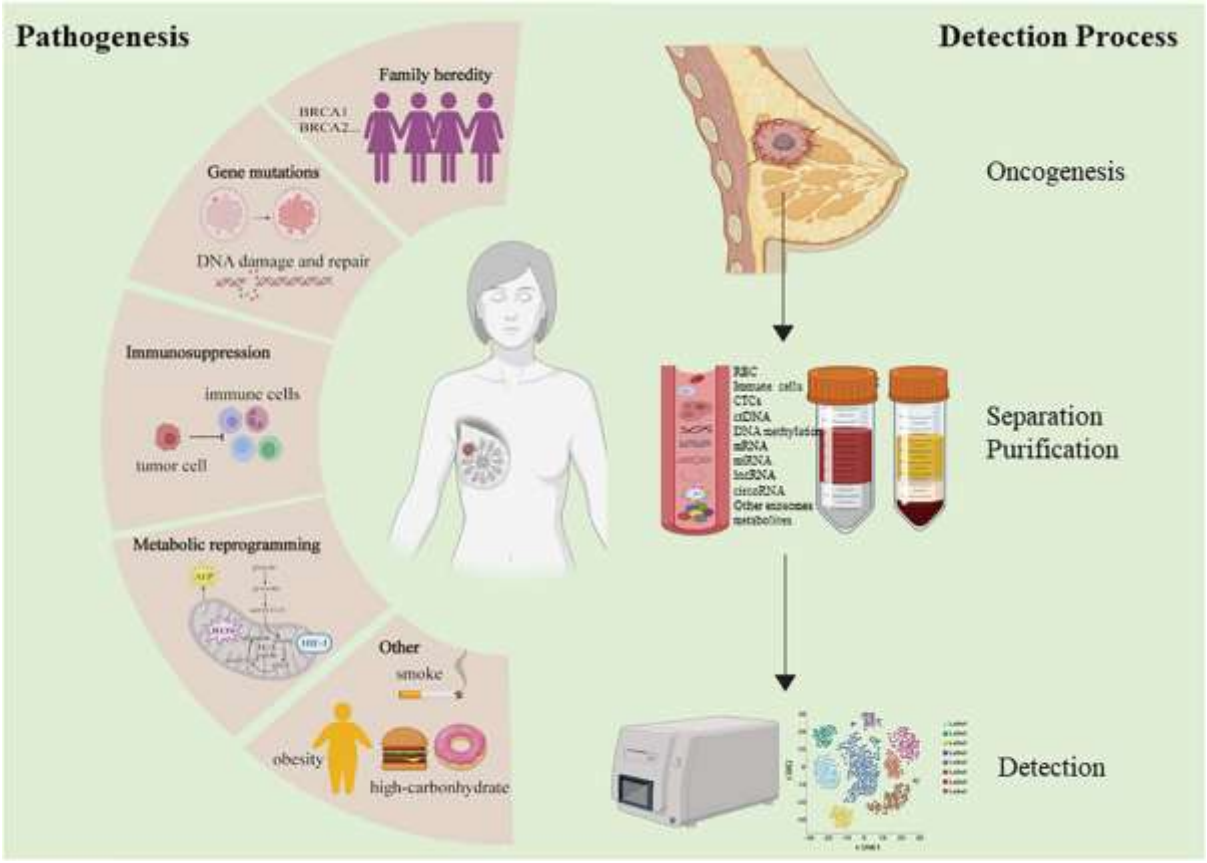

Figure 1: Circulating tumor biomarkers (source: web)

As a result, they could be used as indicators to find malignancy. Due to their limited diagnostic sensitivity and lack of specificity for early disease, none of these markers have been utilized alone for screening; instead, they are mostly employed to track therapeutic response in patients with advanced disease[13].

Cancer patients may either actively or passively have tumor cells from their primary or metastasized malignancies enter their peripheral circulation. CTCs raise the chance of death and recurrence in early-stage breast cancer [6]. However, CTC testing is not appropriate for identifying breast cancer because to its limited sensitivity and reliability. There is only one CTC for every billion healthy blood cells, making them incredibly rare [7]. Target mRNA synthesis is regulated by miRNAs, which are tiny regulatory RNA molecules that connect complementary sequences in the 3′ untranslated region.

3. MATERIAL AND METHODS

Transmembrane proteins are present in the lipid bilayer that envelops them. EVs have drawn more attention as cancer biomarkers because they can mimic the characteristics of the tumor's origin and condition. When compared to healthy controls, breast cancer patients' peripheral blood has been discovered to have more EVs. The quantity of EVs by itself, however, is insufficiently precise to diagnose malignancy. For instance, at every stage of breast cancer, the amounts of developmental endothelial locus-1 (Del-1) and cancer-associated fibronectin proteins found in circulating EVs were markedly increased; however, following tumor excision, these levels recovered too normal[14].

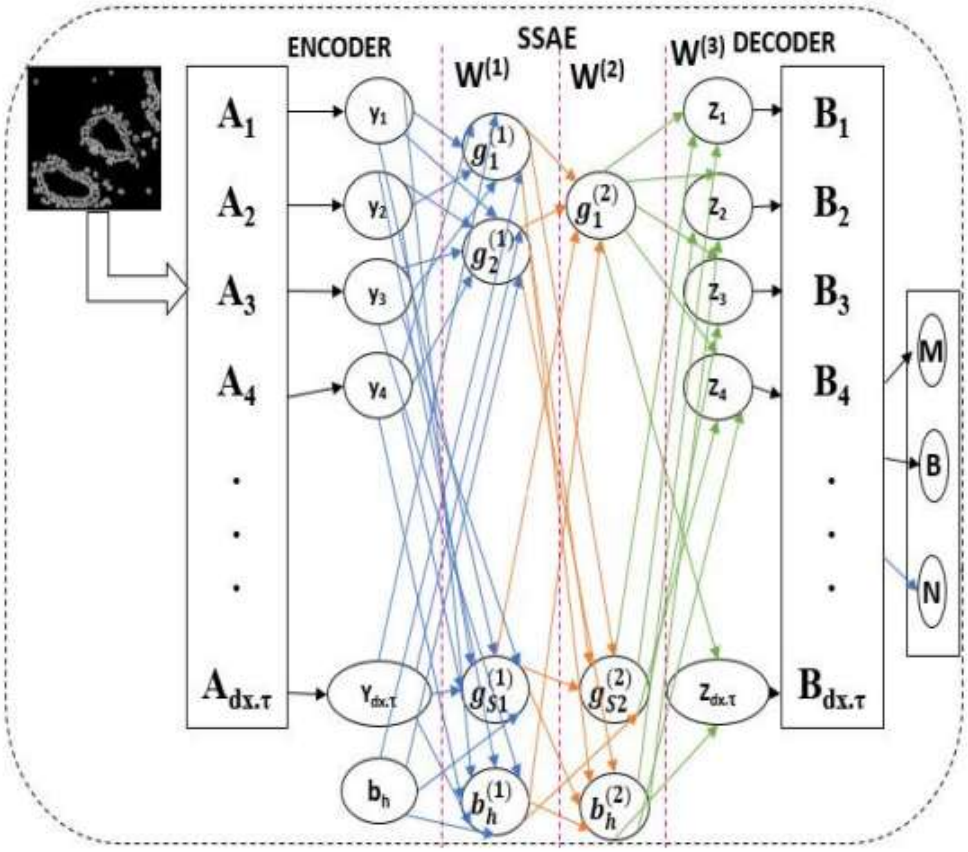

Figure 2: The proposed architecture

EVs have been isolated and characterized using a variety of approaches. As of right now, there are no established techniques for EV separation and quantification. It has been noted that the isolation techniques employed affect the characteristics of EVs obtained from the same material source. Because of this, using EVs as a diagnostic biomarker has become increasingly difficult. There is an urgent need to optimize and standardize the procedures and methods for EV isolation and purification. Furthermore, we still know very little about EVs. The precise molecular processes underlying the synthesis, release, and activity of EVs also require more investigation. Phospholipids are the fundamental components of biological membranes.

Exosomes can also be found in urine. They employed computed models for early breast cancer diagnosis and found patterns particular to cancer based on these profiles. Urine collection has been used to find cancer biomarkers since it is convenient and non-invasive. Urine containing altered proteins, metabolites, miRNAs, or other biological components may be a sign of breast cancer. The specificity and sensitivity of the currently available urine breast cancer biomarkers need to be confirmed in cohort studies, given they are still in the biomarker discovery stage [9]. In addition to being a natural byproduct of pathological conditions or regular metabolic processes, the body also naturally releases semi-volatile chemicals and volatile organic compounds (VOCs) in human breath. Numerous cancers have been identified using chemical analysis of patients' exhaled breath. The usefulness 1990s when it was discovered that women with the disease had greater amounts of pentane in their breath. More importantly, this breath test was more accurate in identifying even though it had a lower positive predictive value than a screening mammography test.

4. RESULT AND DISCUSSION

This made it abundantly evident that breathalyzers may be used as the main method of screening for breast cancer. Numerous more studies have further demonstrated the breath test's capacity to detect breast cancer [15]. Advances in data modeling, analytical tools, and breath collection techniques are enabling the active development of a clinical.

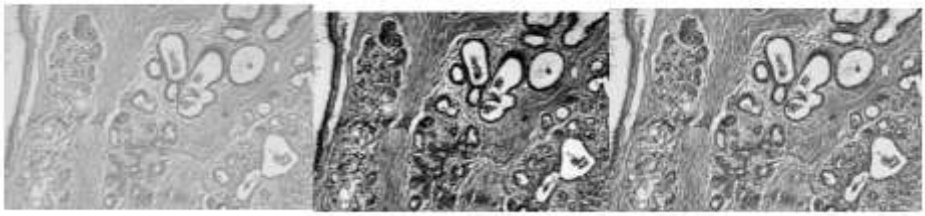

Figure 3: The image pre-processing to improvise the quality of image without losing any features

In one study, low-cost commercial electronic noses were used to detect distinctive breath patterns in breast cancer patients. Using information from the electronic noses, an artificial neural network model was able to detect patients. According to a pilot study, this approach might reliably detect women with abnormal mammography and breast cancer.

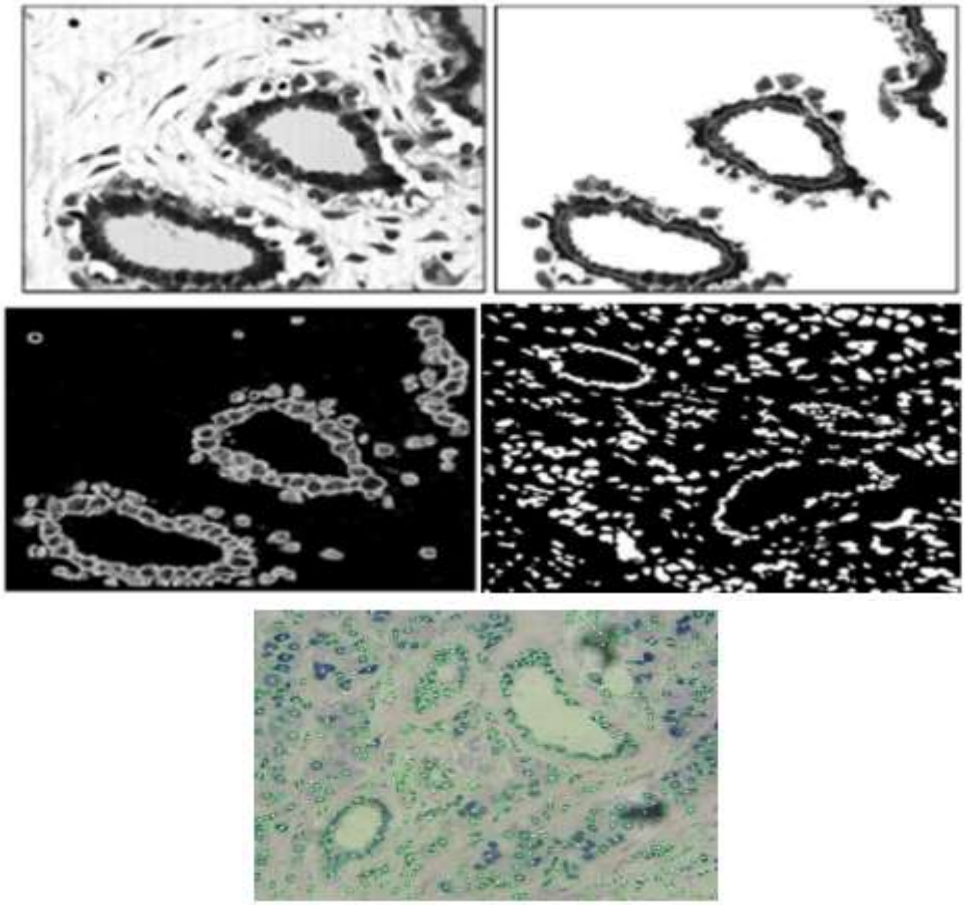

Figure 4: The nuclei segmentation on H&E tainted images

A new update was made to the findings of this prospective clinical validation research. Menssana Research Inc. has developed ultra-clean breath collecting balloons to make it easier to collect breath and analyse volatile organic compounds. They might cut back on the number of mammograms performed in clinics to test for and track breast cancer. Due to a number of variables, such as the physiological condition of the patient, the test setting, the methods used to collect breath, and the analysis methodology.

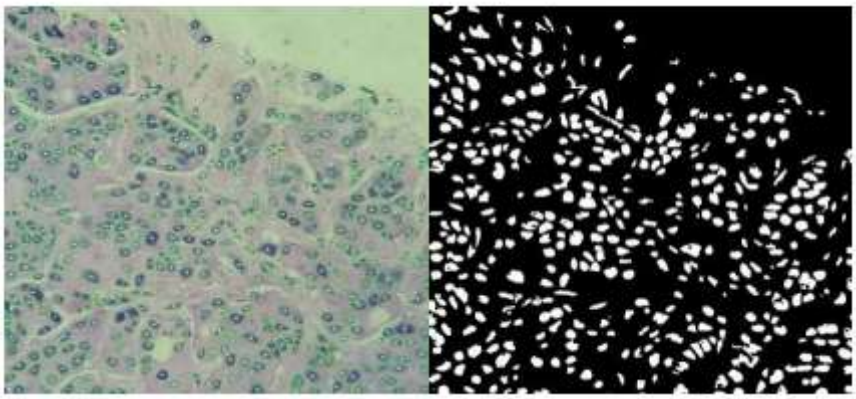

Figure 5: White region represents the cell membrane

Breast epithelial duct cells naturally release NAF, a secretion, in the breast. In healthy nonlactating women, it can be obtained by nipple aspiration or other techniques. Women with brown or bloody nipple discharge are more likely to develop.

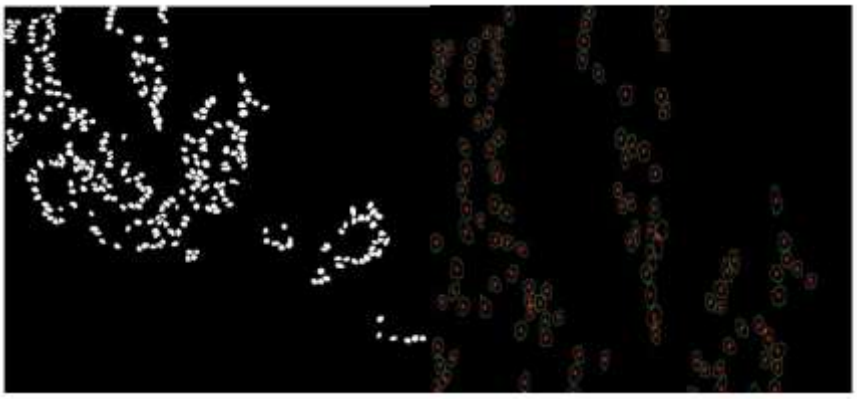

Figure 6: The processed histopathological images

According to a number of studies, the levels of drugs, proteins, and hormones in NAF are a more accurate representation of the exposure and metabolic byproducts in breast tissue than those in serum or plasma.

5. CONCLUSION

NAFs should contain considerably more chemicals specific to breast cancer than other circulating bodily fluids because NAF is located at the location of the illness.Even if the existing ctDNA methylation signatures are not very effective at identifying breast cancer, a recently developed algorithm that uses ctDNA taken from breast tissue may improve the sensitivity of the diagnosis. When combined with mammography, we expect the breath test to dramatically lower the number of false-positive and false-negative mammogram diagnoses.Breath tests are easy and non-invasive, and they may be able to identify cancer early on. They are also useful for screening big groups of people.

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