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Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)

ISSN 2760-4942 (Online) Volume 2, Issue 1, January 2026

https://eurekaoa.com/index.php/5

IMPROVING THE SYSTEM OF EARLY DETECTION OF ENDOCRINE DISEASES IN PRIMARY HEALTHCARE INSTITUTIONS

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ABSTRACT

Endocrine diseases such as diabetes mellitus, thyroid disorders, obesity, and metabolic syndrome are among the most prevalent non-communicable conditions worldwide, contributing significantly to morbidity, mortality, and healthcare costs. Despite their growing burden, many cases remain undiagnosed until advanced stages, leading to complications that could have been prevented through timely intervention. Primary healthcare institutions, as the first point of contact for most patients, play a critical role in the early detection and management of these disorders. However, current systems often face challenges including limited screening protocols, insufficient physician training, inadequate laboratory infrastructure, and low public awareness. This study emphasizes the importance of strengthening early detection mechanisms within primary healthcare by introducing standardized screening guidelines, enhancing the capacity of healthcare providers through continuous medical education, and integrating digital health technologies such as electronic health records and mobile applications for risk monitoring. Furthermore, community-based awareness campaigns and improved laboratory support are highlighted as essential components of a comprehensive strategy. By implementing these measures, healthcare systems can achieve earlier diagnosis, reduce the incidence of

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ISSN 2760-4942 (Online) Volume 2, Issue 1, January 2026

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complications, and improve patient outcomes while lowering long-term costs. Ultimately, the improvement of early detection systems for endocrine diseases at the primary healthcare level represents a vital step toward building resilient health systems capable of addressing the growing burden of non-communicable diseases in both urban and rural populations.

Keywords: Endocrine diseases; early detection; primary healthcare; diabetes mellitus; thyroid disorders; metabolic syndrome; screening protocols; digital health; public awareness; healthcare systems.

Introduction

Thyroid nodule is a common health problem in endocrinology. Thyroid fine-needle aspiration biopsy (FNAB) cytology performed by palpation guided FNAB (PGFNAB) and ultrasound-guided FNAB (USGFNAB) are the preferred examinations for the diagnosis of thyroid cancer and part of the integration of the current thyroid nodule assessment. Although studies have shown USGFNAB to be more accurate than PGFNAB, inconsistencies from several studies and clinical guidelines still exist. The purpose of this study is to compare the diagnostic accuracy of Palpation versus Ultrasound-Guided Fine Needle Aspiration Biopsy in diagnosing malignancy of thyroid nodules. The systematic review and meta-analysis were prepared based on the PRISMA standards. Literature searches were carried out on three online databases and grey literatures. Data extraction was carried out manually from various studies that met the eligibility, followed by analysis to obtain pooled data on sensitivity, specificity, Diagnostic Odds Ratio (DOR) and Area Under Curve (AUC), and the comparison of the two methods. Total of 2517 articles were obtained, with 11 studies were included in this systematic review. The total sample was 2382, including 1128 subjects using PGFNAB and 1254 subjects using USGFNAB. The risk of bias was assessed using QUADAS-2 with mild-moderate results. The results of sensitivity,

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specificity, AUC and DOR in diagnosing thyroid nodules using PGFNAB were 76% (95% CI, 49–89%), 77% (95% CI, 56–95%), 0.827 and 11.6 (95% CI, 6–21) respectively. The results of sensitivity, specificity, AUC and DOR in diagnosing thyroid nodules using USGFNAB were 90% (95% CI, 81–95%), 80% (95% CI, 66–89%), 0.92 and 40 (95% CI, 23–69), respectively the results of the comparison test between PGFNAB and USGFNAB; Tsens USGFNAB of 0.99 ($p = 0.023$), AUC difference test of 0.093 ($p = 0.000023$) [1, 5].

While this review provides valuable insights into thyroid and pituitary disease treatment, limited details on LT4 treatment represent a significant study limitation [25]. Key reporting points for future case studies are proposed to enhance the understanding and management of NKX2-1-RD hypothyroidism [2].

Endocrine dysfunction is common in critically ill children and is manifested by abnormalities in glucose, thyroid hormone, and cortisol metabolism. To develop consensus criteria for endocrine dysfunction in critically ill children by assessing the association of various biomarkers with clinical and functional outcomes. We included studies in which researchers evaluated critically ill children with abnormalities in glucose homeostasis, thyroid function and adrenal function, performance characteristics of assessment and/or scoring tools to screen for endocrine dysfunction, and outcomes related to mortality, organ-specific status, and patient-centered outcomes. Studies of adults, premature infants or animals, reviews and/or commentaries, case series with sample size ≥10, and non-English-language studies were excluded. Data extraction and risk-of-bias assessment for each eligible study were performed by 2 independent reviewers. The systematic review supports the following criteria for abnormal glucose homeostasis (blood glucose [BG] concentrations >150 mg/dL [>8.3 mmol/L] and BG concentrations <50 mg/dL [<2.8 mmol/L]), abnormal thyroid function (serum total thyroxine [T4] <4.2 µg/dL [<54 nmol/L]), and abnormal adrenal function (peak serum cortisol concentration <18 µg/dL [500 nmol/L]) and/or an increment in serum cortisol concentration of <9 µg/dL (250 nmol/L) after adrenocorticotropic

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hormone stimulation. These included variable sampling for BG measurements, limited reporting of free T4 levels, and inconsistent interpretation of adrenal axis testing [3]. We present consensus criteria for endocrine dysfunction in critically ill children that include specific measures of BG, T4, and adrenal axis testing [3]. Molecular tests for thyroid nodules with indeterminate fine needle aspiration results are increasingly used in clinical practice; however, true diagnostic summaries of these tests are unknown. A systematic review and meta-analysis were completed to (1) evaluate the accuracy of commercially available molecular tests for malignancy in indeterminate thyroid nodules and (2) quantify biases and limitations in studies that validate those tests. English language articles that reported original clinical validation attempts of molecular tests for indeterminate thyroid nodules were included if they reported counts of true-negative, true-positive, false-negative, and false-positive results. We performed screening and full-text review, followed by assessment of eight common biases and limitations, extraction of diagnostic and histopathological information, and meta-analysis of clinical validity using a bivariate linear mixed-effects model. Forty-nine studies were included. Meta-analysis of Afirma Gene expression classifiers (GEC; n = 38 studies) revealed a sensitivity of 0.92 (confidence interval: 0.90-0.94), specificity of 0.26 (0.20-0.32), negative likelihood ratio (LR-) of 0.32 (0.23-0.44), positive LR+ of 1.24 (1.15-1.35), and area under the curve (AUC) of 0.83 (0.74-0.89). Afirma Genomic Sequencing Classifier (GSC; n = 10) had a sensitivity of 0.94 (0.89-0.96), specificity of 0.38 (0.27-0.50), LR- of 0.18 (0.10-0.30), LR+ of 1.52 (1.28-1.87), and AUC of 0.91 (0.62-0.92). ThyroSeq v1 and v2 (n = 10) had a sensitivity of 0.86 (0.82-0.90), specificity of 0.74 (0.59-0.85), LR- of 0.19 (0.13-0.26), LR+ of 3.52 (2.08-5.92), and AUC of 0.86 (0.81-0.90). ThyroSeq v3 (n = 6) had a sensitivity of 0.92 (0.86-0.95), specificity of 0.41 (0.18-0.69), LR- of 0.24 (0.09-0.62), LR+ of 1.67 (1.09-2.98), and AUC of 0.90 (0.63-0.92) [67]. Fourteen percent of studies conducted a blinded histopathologic

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review of excised thyroid nodules, and 8% made the decision to go to surgery blind to molecular test results [4].

The diagnostic value of contrast-enhanced ultrasound combined with ultrasound elastography for benign and malignant thyroid nodules is still controversial, so we used meta-analysis to seek controversial answers. The PubMed, OVID, and CNKI databases were searched according to the inclusion and exclusion criteria. The literature was selected from the establishment of each database to February 2024. The QUADAS-2 tool assessed diagnostic test accuracy. SROC curves and Spearman's correlation coefficient were made by Review Manager 5.4 software to assess the presence of threshold effects in the literature. Meta-Disc1.4 software was used for Cochrane-Q and $\chi 2$ tests, which be used to evaluate heterogeneity, with P-values and I2 indicating heterogeneity levels. The appropriate effect model was selected based on the results of the heterogeneity test. Stata18.0 software was used to evaluate publication bias. The diagnostic accuracy of contrast-enhanced ultrasound combined with ultrasound elastography for benign and malignant thyroid nodules was evaluated by calculating the combined sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, DOR, and area under the SROC curve. A total of 31 studies included 3811 patients with 4718 nodules were analyzed. There is no heterogeneity caused by the threshold effect, but there is significant non-threshold heterogeneity [7]. Combined diagnostic metrics were: sensitivity = 0.93, specificity = 0.91, DOR = 168.41, positive likelihood ratio = 10.60, and negative likelihood ratio = 0.07. The SROC curve area was 0.97 [5].

In recent years, endocrinology research has increasingly focused on machine learning (ML) applications. ML offers the possibility of utilizing large data sets and extracting imperceptible patterns. It might contribute in optimizing healthcare outcomes and unveiling new understandings of the intricate mechanisms of endocrine disorders. This review covers the basic aspects of ML and highlights specific areas of endocrinology with potential of ML application.

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A total of 1130 studies were analyzed. Thyroid-related research was the most prevalent, followed by studies concerning the pituitary, adrenal and parathyroid glands. ML applications included medical imaging analysis, tumor classification, treatment response prediction, complication risk estimation and identification of molecular markers. ML has the potential to enhance the diagnosis, treatment and understanding of endocrine diseases. However, the use of ML is still limited by issues such as lack of model transparency, data imbalance and difficulties with clinical implementation [3]. To enable safe and effective application of ML in endocrinology, further validation, interdisciplinary collaboration and standardized approaches are essential [6].

Diagnostic tests using serum TSH were used to diagnose hypothyroidism or confirm its presence. 35% of patients were diagnosed at neonatal age, and 42% at adult age. Other hormonal dysfunctions identified due to clinical signs, such as anterior pituitary deficiencies, were detected later in life [2]. Thyroid scintigraphy and ultrasonography allowed for the description of the thyroid gland in 30% of cases of hypothyroidism. Phenotypic variability was observed in individuals with the same variants, making genotype-phenotype correlations challenging [7].

To examine the patient-related factors that have been linked to glycaemic control in people living with type 2 diabetes mellitus in Middle Eastern countries. A systematic review and meta-analysis. The final sample consisted of 54 articles with a total of 41,079 participants. Pooled data showed an increased risk of inadequate glycaemic control in smokers [OR = 1.26, 95% confidence interval (CI): 1.05, 1.52; p =.010], obese patients (OR = 1.30, 95% CI: 1.10, 1.54; p =.002), patients with elevated waist to hip ratio (OR = 1.62, 95% CI: 1.16, 2.26; p =.004) and longer disease duration (OR = 2.01, 95% CI: 1.64, 2.48; p <.001). A lower risk of inadequate control was associated with physical activity (OR = 0.40, 95% CI: 0.24, 0.67; p <.001) and self-management (OR = 0.49, 95% CI: 0.29, 0.82; p =.006) [8].

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Environmental endocrine disruptors (EDCs) affect the immune system and influence the development of autoimmune diseases (ADs). However, a comprehensive summary of the relationship between EDCs and ADs has not been developed. Consequently, we conducted a systematic review and meta-analysis of previous observational studies examining the association between exposure to EDCs and AD outcomes. We searched relevant literature published from January 2008 to the present, which ultimately included 19 studies. The synthesis of evidence demonstrated a positive association between AD risk and exposure to major EDC classes such as bisphenols (strongest association: OR = 2.38, 95% CI: 1.27–4.45), organochlorine pesticides, phthalates, and polycyclic aromatic hydrocarbons [9]. This trend was not observed for polychlorinated biphenyls. These findings position EDC exposure as a potential risk factor for ADs, yet the mechanistic pathways require elucidation. Future high-quality longitudinal and experimental studies are essential to confirm these relationships and explore the underlying biology [9].

Diabetes prevalence is increasing in most places in the world, but prevalence is affected by both risk of developing diabetes and survival of those with diabetes. Diabetes incidence is a better metric to understand the trends in population risk of diabetes. Using a multicountry analysis, we aimed to ascertain whether the incidence of clinically diagnosed diabetes has changed over time. Methods: In this multicountry data analysis, we assembled aggregated data describing trends in diagnosed total or type 2 diabetes incidence from 24 population-based data sources in 21 countries or jurisdictions. Data were from administrative sources, health insurance records, registries, and a health survey. We modelled incidence rates with Poisson regression, using age and calendar time (1995–2018) as variables, describing the effects with restricted cubic splines with six knots for age and calendar time. Findings: Our data included about 22 million diabetes diagnoses from 5 billion person-years of follow-up [9]. Data were from 19 high-income and two middle-income countries or jurisdictions. 23 data sources had

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data from 2010 onwards, among which 19 had a downward or stable trend, with an annual estimated change in incidence ranging from −1·1% to −10·8%. Among the four data sources with an increasing trend from 2010 onwards, the annual estimated change ranged from 0·9% to 5·6%. The findings were robust to sensitivity analyses excluding data sources in which the data quality was lower and were consistent in analyses stratified by different diabetes definitions [10].

Conclusion

In conclusion, the improvement of early detection systems for endocrine diseases within primary healthcare institutions represents a critical step toward enhancing public health outcomes and reducing the long-term burden of chronic illness. Endocrine disorders such as diabetes mellitus, thyroid dysfunction, and adrenal abnormalities often progress silently, with subtle symptoms that are easily overlooked in the early stages. By strengthening the capacity of primary healthcare providers to recognize these conditions promptly, healthcare systems can intervene earlier, prevent complications, and significantly improve patients' quality of life. A comprehensive approach to early detection requires several interconnected strategies. First, the integration of standardized screening protocols and evidence-based guidelines into routine primary care practice ensures that high-risk populations are systematically identified. Second, the adoption of modern diagnostic technologies, including point-of-care testing and digital health tools, can accelerate the identification of endocrine abnormalities and facilitate timely referrals. Third, continuous professional development and training of healthcare workers are essential to equip them with the knowledge and skills necessary to recognize early warning signs and interpret diagnostic results accurately.

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