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Enhancing Paediatric Diagnostic Accuracy: A Case Report on the Clinical Utility of MedBrain in Nigeria

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ABSTRACT

Diagnosing childhood illnesses can often be challenging, particularly with conditions that share overlapping symptoms. This case report examines the role of MedBrain, a Clinical Decision Support System (CDSS), in diagnosing common childhood illnesses. The report discusses two clinical cases involving a 9-year-old child diagnosed with chickenpox and a 4-year-old child diagnosed with measles, both in Nigeria. For each case, MedBrain provided a differential diagnosis with a ranked list of diseases and associated diagnostic scores based on the system's algorithms. The predicted diagnoses were evaluated and validated by paediatricians, demonstrating the diagnostic clinical utility of MedBrain. This case report offered valuable insights into MedBrain's functionality, clinical relevance, and potential in clinical research, with the capability to improve diagnostic accuracy in paediatric care.

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Introduction

Diagnosing childhood illnesses can often be challenging, particularly with conditions that share overlapping symptoms [1,2]. Conditions such as chickenpox (varicella) and measles require accurate and timely diagnoses to ensure appropriate treatment and avoid complications [3]. The Lancet's Commission on Diagnostics reports that 47% of the global population lacks access to medical diagnoses, with primary care settings being the critical point for diagnostics [4]. Resource shortages in these settings particularly affect poor, rural, and marginalised communities [5]. The global diagnostic gap is mainly due to a shortage of medical specialists and limited access to gold-standard diagnostic tests [6]. Recent advancements in technology, such as Clinical Decision Support Systems (CDSS), aim to assist healthcare professionals in making informed decisions [7]. MedBrain®, an app-based CDSS, has emerged as a promising tool to enhance diagnostic accuracy in paediatric care [7-9]. This manuscript describes two cases where MedBrain® played an essential role in diagnosing childhood illnesses, providing insights into its functionality, clinical utility, and potential in clinical research.

Case presentation

Case 1

A Nigerian 9-year-old male presented with mild fever, fatigue, irritability, and a general feeling of malaise. These symptoms persisted for the first two days, during which a characteristic rash developed. Initially, the rash appeared on the torso and scalp before gradually spreading to the face, arms, and legs. The rash began as small red spots, which quickly evolved into fluid-filled blisters (vesicles). The blisters were intensely itchy, causing the child to scratch them frequently.

On physical examination, the skin findings revealed clusters of vesicles at various stages of healing (Figure 1). The lesions consisted of a mix of multiple spots, blisters, and crusted lesions, each at different stages of development. The rash was predominantly concentrated on the torso, with fewer lesions found on other parts of the body. Based on the clinical presentation, the diagnosis of chickenpox (varicella) was made. The key risk factors included age (common in children), and there was no prior history of vaccination against varicella.

Figure 1: A case of chickenpox (varicella). Clusters of vesicles at various stages of healing diagnosis

The MedBrain Differential diagnosis included chickenpox (varicella) with diagnostic score of 95%. The symptoms matched included fever, generalised vesicular rash at multiple stages of development, itchiness, and distribution of lesions. The second differential included impetigo with diagnostic score of 3%, with symptoms matched of skin lesions and crusting. This diagnosis was rejected due to absence of golden-yellow crusts, no localised grouping of lesions, and no associated fever. The third differential was allergic rash with diagnostic score of 2% and the symptoms matched was itchy rash. The third diagnosis was rejected due to absence of specific allergen exposure history and the presence of systemic symptoms like fever. A paediatrician confirmed the diagnosis of chickenpox, validating MedBrain's top-ranked prediction. The patient recovered fully within nine days with supportive care.

Case 2

A Nigerian 4-year-old female presented with a high-grade fever of 39.3ºC, which persisted for three days before other symptoms appeared. The fever was resistant to over-the-counter fever reducers, causing concern for the child's parents. In addition to the fever, the child showed signs of general malaise, irritability, and a decreased appetite. Over time, the patient developed a characteristic maculopapular rash. Initially, the rash appeared at the hairline and behind the ears, then spread downwards to the face, neck, trunk, arms, and eventually the legs. The rash was accompanied by a persistent cough, coryza (runny nose), and conjunctivitis, which are hallmark symptoms of measles. However, the patient did not show the characteristic Koplik spots on the oral mucosa, which are typically seen in the early stages of measles. The key risk factors identified in the patient included lack of measles vaccination, age (common in young children), and endemic setting in Nigeria. On examination, the lungs were clear on auscultation, with no signs of breathing difficulty or chest in-drawing. The child appeared fatigued and uncomfortable, likely due to the fever and rash (Figure 2). MedBrain's differential diagnosis ranked measles as the most likely condition with a diagnostic score of 92%, based on the presence of high fever, characteristic rash distribution, cough, coryza, and conjunctivitis. The second differential diagnosis suggested by MedBrain was scarlet fever, with a diagnostic score of 5%, matching symptoms of fever and rash. However, this diagnosis was ruled out due to the absence of pharyngitis, a strawberry tongue, and the sandpaper-like texture of the rash. The third diagnosis was rubella (German measles), with a diagnostic score of 3%, supported by symptoms of rash and fever. This diagnosis was also excluded due to the absence of posterior auricular lymphadenopathy and less prominent systemic symptoms compared to measles. Based on the clinical findings, MedBrain diagnosed the patient with measles, a conclusion confirmed by the attending paediatrician. The patient recovered over several days with supportive care.

Figure 2: A case of measles. It has a characteristic maculopapular rash.

Discussion

Interpretation with Current Literature

Chickenpox and measles are both highly contagious viral infections with distinct clinical presentations, though they share overlapping features, such as fever and rash. Studies have shown that accurate diagnosis is critical to avoid complications such as secondary bacterial infections or pneumonia in measles, and complications like encephalitis in chickenpox [10-12]. Clinical decision support tools such as MedBrain® provide healthcare providers with valuable assistance in differentiating between these conditions, reducing diagnostic errors and improving patient outcomes [13]. In this case report, it is emphasized that these two diseases were not specifically 'selected' but were identified by chance. However, MedBrain® is not limited to these two conditions—it encompasses over 150 diseases. We tested MedBrain with two patients who happened to have chickenpox and measles purely by coincidence. Despite this, the diagnostic accuracy of MedBrain applies equally to over 150 paediatric conditions, that are highly prevalent or highly lethal in sub-Saharan Africa. MedBrain is an app-based CDSS that aids in generating clinical diagnoses by collecting and analyzing patient data. It incorporates a medical library containing likelihood ratios for various symptoms, physical signs, and risk factors [8, 14]. Healthcare professionals input relevant patient data, such as symptoms, physical signs, medical history, other risk factors.. MedBrain® then generates a dynamic clinical interview, where it asks a series of specific questions based on the information provided [8]. These questions are tailored to the patient's condition, and the responses guide the system through an iterative process. Once the system reaches a predetermined threshold, it generates a diagnostic prediction.

MedBrain® offers several essential features, including: (1) a Medical Library of Likelihood Ratios, containing weighted diagnostic information for various diseases derived from sensitivity and specificity data [8]. To develop the paediatric medical library, the team collaborated with senior paediatric consultants, utilizing data from the Nigerian Ministry of Health's official clinical practice guidelines and the WHO Integrated Management of Neonatal and Childhood Illnesses (IMNCI) paediatric guidelines. Likelihood ratios were calculated based on the evidence of symptom and physical sign sensitivity and specificity for each disease; (2) a Disease Rank Algorithm that generates a ranked list of potential diagnoses based on patient data; (3) a Tag Rank Algorithm that identifies critical clinical tags (symptoms and signs) associated with the most probable diseases and prompts further questions; and (4) a Step-by-Step Guide that guides users through the clinical interview and physical examination to achieve a reliable diagnosis [8]. In the cases of chickenpox and measles, MedBrain®'s capability to analyze complex clinical data and provide accurate diagnoses was validated by paediatricians.

Clinical Implications

The use of MedBrain® for diagnosing childhood illnesses has significant implications for clinical practice. By providing a structured approach to symptom analysis, MedBrain® may help reduce human error, particularly in paediatrician settings where diagnostic uncertainty is common. It may enhance diagnostic efficiency, helping healthcare professionals make timely decisions that can improve patient care. MedBrain® may also empower healthcare workers with varying levels of experience, enabling them to make more informed decisions based on evidence-based algorithms.

Implications for Clinical Research

MedBrain®'s application in clinical research offers a unique opportunity to analyse large datasets and identify trends in paediatric diagnoses. In this case report, the paediatricians were clearly in Nigeria, and the MedBrain diagnosis was validated against the pediatrician's clinical (symptom-based) diagnosis, not against laboratory tests. By aggregating data from multiple healthcare settings, MedBrain® can help researchers identify common diagnostic pitfalls, track demographic and epidemiological trends improve decision-making protocols, and assess the effectiveness of treatments across different population groups. The real-time data collection provided by MedBrain® also supports evidence-based research into disease prevalence, symptomatology, and treatment outcomes.

Strengths and Limitations

Our study highlights several key strengths of MedBrain®. Its accuracy stands out, delivering reliable diagnostic predictions that have been validated by paediatricians in this case report. MedBrain® is also highly efficient, enabling healthcare professionals to make timely diagnoses, which improves patient care and reduces waiting times. Its user-friendly interface simplifies the diagnostic process, making it accessible to healthcare providers with varying levels of expertise. Furthermore, MedBrain® is versatile, suitable for use in a wide range of healthcare settings, including primary care, hospitals, and rural clinics. As a smartphone app capable of functioning offline, it ensures uninterrupted access and availability.

Currently, MedBrain® operates solely on the comprehensive medical library developed by a team of paediatricians within the MedBrain staff. Its performance does not rely on user-inputted data. While future updates may incorporate supervised machine learning to allow the system to learn from aggregated patient data, this feature is not part of MedBrain's current functionality.

However, some limitations should be noted. MedBrain® simplifies the diagnostic process for inexperienced healthcare practitioners by tailoring physical examinations. Instead of conducting a detailed physical exam, users can focus on confirming or excluding specific physical signs prompted by MedBrain®, streamlining the process and making it more manageable for less experienced providers.

Conclusion

MedBrain® is a promising tool for diagnosing childhood illnesses, as demonstrated in the cases of chickenpox and measles. It provides a structured, efficient, and accurate method for clinical decision-making, especially in settings with limited access to specialists. By providing structured diagnostic predictions, it may complement clinical judgment and supports timely, accurate decision-making. Further research, especially the randomised control trial, is needed to explore MedBrain®'s performance across a wider range of paediatric diseases. Expanding its accessibility and integrating it into routine clinical practice could have significant benefits in improving diagnostic accuracy and patient outcomes, especially when there is no specialist.

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Disclosure

The authors declare that there is no conflict of interest in this work.

Ethical Consideration

Consent was obtained from the parents of the index patients to allow the reporting and displaying of pictures where necessary.

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Author Contributions

GUE and OCN conceived and supervised the study; CAN, CDN, DRS, OLI, JAU, EIN, and CGO analysed data; GUE, and CAN wrote the manuscript; GUE, ICU, CCN, PCD, JEM and NCE made manuscript revisions. All authors reviewed the results and approved of the final version of the manuscript.

Ethics Approval and Consent to Participate

Not applicable

Consent for Publication

Written informed consents were obtained from the parents of the index patients to publish this case report and any image which accompanied it.

Availability of Data and Materials

Data sharing is not applicable to this article as no datasets were generated or analysed during this study.

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