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The Problem of Diagnosis of Childhood Tuberculosis in Haut-UELE: Genexpert or Keith Edward Score or Both?

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Abstract **Original Research Article**

Introduction: Diagnosing Tuberculosis (TB) in children is a major challenge. This study aims to evaluate the diagnostic performance of the Keith-Edward score compared to the Genexpert in health care facilities (HCF) in Haut-Uélé province, in the northeast of the Democratic Republic of Congo (DRC). ***Methods:*** Using a documentary review, we collected sociodemographic, clinical and paraclinical data. retrospectively from 105 children included in our study. We represented the performance of the Keith-Edward score using the Receiver Operating Curve (ROC) curve and also calculated the area under the ROC curve (AUC) as well as all the parameters of this curve. In all cases, the significance threshold was 5% (p-value < 0.5). The rest of the methodological approach is described in our previous article [15]. ***Results:*** Keith-Edward score performance analysis showed that the area under the curve was 0.73. Its sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were 66.67%, 67.86%, 34.1% and 89.1%, respectively. ***Conclusion:*** The Keith-Edward score was found to be less effective and therefore could not be recommended as the sole means of diagnosing tuberculosis in children.

Keywords: tuberculosis, children, Keith-Edward, GeneXpert.

1. INTRODUCTION

Tuberculosis (TB) remains a major public health (PH) problem worldwide. According to the World Health Organization (WHO) report, approximately 10.6 million people developed TB in 2022, including approximately 1.1 million children, representing 11% of all cases worldwide. Although pediatric TB is often underdiagnosed due to its atypical manifestations and the difficulty of obtaining appropriate biological samples, it is a key indicator of community transmission. Child mortality due to TB is of concern, with nearly 226,000 deaths in 2022, largely related to insufficient access to diagnosis and treatment. Furthermore, the emergence of multidrug-resistant TB (MDR-TB) further complicates its management (CM), particularly in resource-limited settings [1,8].

Africa is one of the continents most affected by TB, with a high incidence in several sub-Saharan countries. The African region accounts for approximately 25% of cases worldwide, with particularly high rates in South Africa, Nigeria, and the Democratic Republic of Congo (DRC) [2,3].

The Democratic Republic of Congo (DRC), with an estimated incidence of 323 cases per 100,000 inhabitants in 2022 [4], is among the 10 countries classified by the WHO as having a high burden of TB disease [5]. In children, the situation is alarming due to difficulties in diagnosis and delayed management. A study carried out in Kinshasa revealed that the majority of children admitted for pulmonary TB had severe forms at the time of diagnosis against a background of malnutrition [4]. The Congolese health system faces major challenges, including the lack of qualified human resources in pediatrics and limited access to advanced diagnostic tests such as GeneXpert [6].

Genexpert is a rapid molecular diagnostic tool that has transformed TB detection, particularly in children, where diagnosis can be challenging [7]. Sputum smear microscopy has limited sensitivity,

especially in children who have lower bacillary loads and struggle to produce good-quality sputum samples. TB culture remains the gold standard for definitive diagnosis, but it is more time-consuming, and WHO has recommended the use of GeneXpert Ultra for rapid diagnosis [9]. Serological tests, which detect antibodies to mycobacterial protein antigens, have demonstrated low sensitivity and specificity compared to standard culture methods and have failed to improve patient outcomes [10]. Given these limitations, GeneXpert, a nucleic acid amplification test that detects *Mycobacterium tuberculosis* DNA and rifampicin resistance in less than two hours, has been hailed as a significant advance in TB diagnosis [7]. The speed and sensitivity of GeneXpert allow for earlier identification of TB cases, enabling rapid initiation of treatment and reducing transmission of infection. In addition, GeneXpert 's ability to detect resistance to rifampicin, a key anti-TB drug, helps quickly identify patients with drug-resistant TB who require more complex treatment regimens. Although GeneXpert has marked a notable advance in the rapid diagnosis of TB, it is essential for early treatment and infection control. It is imperative to recognize that routine replacement of culture with these tests is not justified due to their low negative predictive value (NPV) and barriers to implementation in low- and middle-income countries, which account for the majority of TB cases [11,12].

Several studies have been conducted to compare the performance of the Keith-Edward clinical score with that of GeneXpert for the diagnosis of TB in children. Most of these studies observed the superiority of the performance of GeneXpert over the Keith-Edward score. However, studies reporting the superiority of the Keith-Edward score over GeneXpert for the diagnosis of TB in children are also available [13].

In resource-limited settings, the Genexpert poses the challenge of accessibility and cost, which limits its widespread use as a first-line diagnostic tool. Therefore, it is essential to understand the strengths and limitations of the GeneXpert, as well as its optimal role in the diagnostic algorithm of childhood TB, especially compared to older diagnostic methods such as the Keith-Edward. Clinical diagnosis based on the Keith Edward score may be less accurate than the GeneXpert, especially in cases where signs and symptoms are atypical or overlap with other common pediatric conditions [14].

The Keith-Edward score, a method based on clinical and radiological criteria, has long been used to diagnose TB in children, but poses the problem of subjectivity and variable sensitivity. The comparison of these two approaches is essential to evaluate the performance of the Keith-Edwards clinical score compared to the standard genexpert method which has already proven its effectiveness, with a view to implementing the diagnostic policy for childhood TB in our region. It is in this context that this study is part of which aims to determine the sensitivity of the clinical score in comparison with the results of Xpert (Gold standard) in Health Care Facilities (HCF) of the Haut-Uélé province, in the northeast of the DRC, a resource-limited environment.

2. METHODS

The methodological approach undertaken in this study is the same as that described in our previous article published in April 2025 (https://doi.org/10.4236/jbm.2025.134018) [15].

we represented the performance of the Keith-Edward score using the Receiver Operating Curve (ROC) curve and also calculated the area under the ROC curve (AUC) as well as all the parameters of this curve. In all cases, the significance threshold was 5% (p-value < 0.5).

3. RESULTS

In total, 105 patients, of all ages, suspected of TB based on the Keith Edward score were sampled and had GeneXpert performed as shown in our previous article [15]. According to the observed results, it appears that the Keith-Edward score was positive in 66.7% of patients (GeneXpert positive) and in 32.1% of non-patients (GeneXpert negative) (p-value = 0.004). (Table 1).

Table 1 : Confusion matrix

Characteristic	GENEXPERT EXPERT		Total	p -value
	Yes N = 21 [1]	**No** N = 84 [1]	N = 105 [1]	
Score de Keith-Edward				**0,004**[2]
Positif	14 (66,7%)	27 (32,1%)	41 (39,0%)	
Négatif	7 (33,3%)	57 (67,9%)	64 (61,0%)	
Total	21 (100,0%)	84 (100,0%)	105 (100,0%)	
[1]n (%)				
[2]Pearson's Chi-squared test				

3.1.2. Courbe ROC (Receiver Operating Curve)

Reading Figure 1 of this study shows that the Keith-Edward score had a lower performance than the Genexpert (considered as gold standard). Its area under the curve was 0.73. (Figure 1).

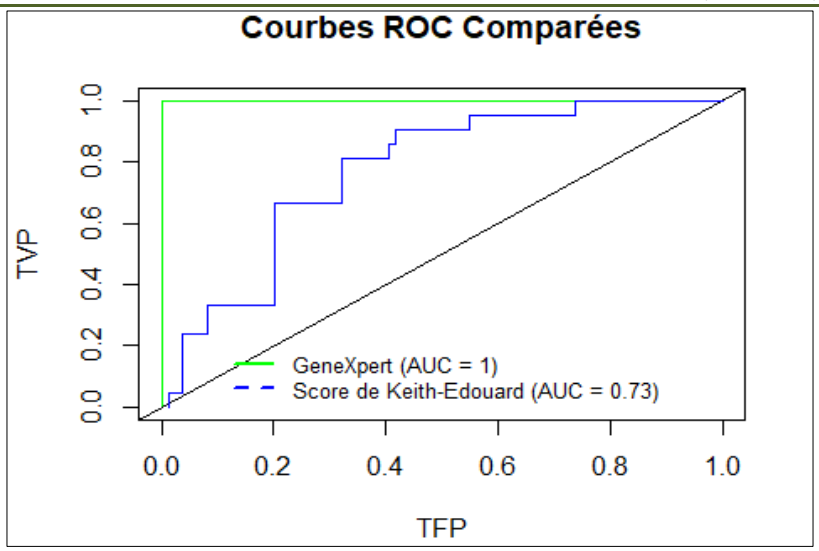

Figure 1: Keith-Edward ROC curve and that of GeneXpert

Table 2 above shows that at the usual threshold (≥ 7), the sensitivity, specificity, positive predictive value and negative predictive value of the Keith-Edward score were 66.67%, 67.86%, 34.1% and 89.1% respectively (Table 2).

Table 2: Parameters of the Keith-Edward curve

Criteria	Sensitivity (IC)	Specificity (IC)	VPP (IC)	VPN (IC)
Score ≥ 7	66.67 (43.0 - 85.4)	67.86 (56.8 - 77.6)	34.1 (25.2 - 44.4)	89.1 (81.4 - 93.8)

CI = 95% Confidence Interval
PPV = Positive Predictive Value (%)
NPV = Negative Predictive Value (%)

4. DISCUSSION

In this study, we compared the performance of the Keith Edouard score with that of GeneXpert (gold standard) for the diagnosis of childhood TB in Haut-Uele, in the northeast of the DRC.

The Keith-Edward score was positive in 66.7% of patients (GeneXpert positive) and in 32.1% of non-patients (GeneXpert negative) (p-value = 0.004).

At the usual threshold (≥ 7), the Keith-Edward score had a less satisfactory performance on several parameters, including its area under the curve (0.73), its sensitivity (66.67%), its specificity (67.86%) and its positive predictive value (34.1%). Only the negative predictive value (89.1%) of this score proved to be satisfactory.

A prospective study conducted in Kimpese, DRC, on 161 children, found that the sensitivity and specificity of the Keith Edward score were 85% and 67.2%, respectively [16] .

This study suggests that the Keith Edwards score might be useful in mass screening, but less so for individual diagnosis due to its low specificity [16] .

Furthermore, Van Rheenen *et al.,* point out that the low specificity of scoring systems may lead to overdiagnosis of tuberculosis and unnecessary use of anti-tuberculosis drugs [17] . They highlight the urgent need for new diagnostic tools for tuberculosis in children, especially in HIV-endemic areas [17] .

A study conducted in Dodoma, central Tanzania, evaluated the performance of the Keith Edwards score in children [18] . The sensitivity was 76.9% and the specificity was 90% [18] . The study concluded that the utility of the Keith Edwards clinical diagnostic tool for the diagnosis of tuberculosis in children is limited, and advocates further validation [18] .

In contrast, a systematic review and meta-analysis by Kakinda *et al.,* assessed the diagnostic accuracy of clinical scoring systems for childhood tuberculosis [19] . They found that, in a sample of 1,000 children with a tuberculosis prevalence of 10%, the Keith Edwards scoring system had a sensitivity of 81.9% and a specificity of 81.2% [19] .GeneXpert test has emerged as a significant advance in the diagnosis of tuberculosis.

In a study by Lupande *et al.*, the performance of GeneXpert MTB/RIF compared to conventional Ziehl-Neelsen microscopy was evaluated in a hospital in Bukavu, DRC [20] . In this study, GeneXpert MTB/RIF detected 13 additional cases of tuberculosis that microscopy had missed.

It appears that tuberculosis culture remains the gold standard for definitive diagnosis, but it is more time-consuming and the WHO has recommended the use of GeneXpert Ultra for rapid diagnosis [21] . The GeneXpert provides a result in 1.75 hours, which includes the presence of genotypic resistance to rifampicin, with a sensitivity and specificity of 98% and 99%, respectively. However, its use in resource-limited settings may be limited by cost and the availability of uninterrupted power supply [22] .

In areas where microbiological confirmation of tuberculosis is not possible, the Tanzanian Ministry of Health recommends the use of a Keith Edwards clinical scoring tool for the diagnosis of tuberculosis in children [18] .

Other studies have shown that the Keith Edwards score has a high sensitivity, meaning it is good at identifying children with TB, but it has a lower specificity, meaning it may misidentify some children as having TB when they do not [16] .

The performance of the Keith Edwards score varies between studies. Indeed, a systematic review and meta-analysis of 14 studies on the performance of clinical diagnostic scores for childhood tuberculosis revealed a wide variability in the sensitivity (23% to 97%) and specificity of different scores, including the Keith Edwards score [19] .

This variability may be attributed to differences in study populations, diagnostic criteria for tuberculosis, and thresholds used to define a positive score.

Furthermore, the sensitivity of light microscopy is low due to the paucibacillary nature of tuberculosis in children and lacks reproducibility [23] .

In the specific context of Haut-Uélé, where resources are limited and access to sophisticated laboratory tests such as GeneXpert may be restricted, the use of the Keith Edwards score could be considered as an initial triage tool to identify children at high risk of tuberculosis, and not as a means of diagnosing tuberculosis due to its low sensitivity.

However, it is crucial to recognize the limitations of this score and combine it with other clinical assessments and, if possible, laboratory tests to confirm the diagnosis.

Therefore, a combined diagnostic approach, integrating the Keith Edwards score, clinical assessment and laboratory tests, is likely to be most effective in the context of Haut-Uélé.

The World Health Organization recommends an integrated diagnostic approach for childhood tuberculosis, which includes clinical assessment, laboratory tests, and history of tuberculosis exposure [19] . In resource-limited settings, a simple clinical score could rapidly identify high-risk patients who should be considered for antituberculosis treatment [24] .

The imperfect specificity of the tests can lead to false positives, which is of particular concern because of the possibility of latent tuberculosis infection, BCG vaccination, and non-tuberculous mycobacterial infections [19] .

The use of scoring systems and algorithms has been shown to be beneficial in the diagnosis of childhood tuberculosis, particularly in lower-level health care settings [19] .

These tools help identify patients requiring further investigation, thus enabling rational management of resources and improved patient outcomes [19] .

Ideally, a diagnostic test should distinguish between affected and unaffected individuals. However, no diagnostic test is perfect. Therefore, when adopting a diagnostic test, there is often a trade-off between patients who do not have the target condition but are incorrectly identified as positive and those who do have the target condition [19] .

Tuberculosis remains a major public health problem worldwide, with approximately one-third of the world's population infected with Mycobacterium tuberculosis, the causative agent of the disease [25] .

The variability in reported performance of the Keith Edwards score suggests that its utility may depend on the specific population and setting. The lower sensitivity and specificity observed in our study, compared with the Kimpese study, could be due to differences in the study population, prevalence of tuberculosis, or other factors.

GeneXpert generally offers higher sensitivity and specificity, particularly for detecting drug-resistant TB strains. However, it is also more expensive and may not be readily available in resource-limited settings. The choice between the Keith Edwards score and GeneXpert may therefore depend on the specific context and available resources.

5. CONCLUSION

At the end of our study, it was observed that the sensitivity, specificity and positive predictive value of the Keith-Edward score are low, not allowing its recommendation for daily use in the diagnosis of tuberculosis in children in our region. Further research is needed to optimize the use of these diagnostic tools and to develop new, more accurate methods for diagnosing tuberculosis in children. The low specificity of the Keith Edward score makes it a less recommended tool for the individual diagnosis of pulmonary tuberculosis in

children, but it could be useful in mass screening in public health [17] .

LIMITS OF THE STUDY

The limitation of this study is that these results cannot be extrapolated to the whole of the DRC because studies carried out elsewhere have demonstrated that the results of the genexpert are a function of the population studied, sampling methods and the diagnostic criteria used.

Conflicts of Interest: The authors declare that they have no conflict of interest.

REFERENCES

1. World Health Organization. Global tuberculosis report 2023. Geneva: WHO; 2023. Available on: https://www.who.int/publications/i/item/9789240068640
2. Nkereuwem E, Owusu SA, Edem VF. Post-tuberculosis lung disease in children and adolescents: A scoping review of definitions, measuring tools, and research gaps. Paediatric Respiratory Reviews. 2024.
3. Bolisomi SB, Basilua JPK, Iyombe JPE, Mawunu M. Haematological disorders in tuberculosis at the Monkole Referral Hospital (Kinshasa, Democratic Republic of the Congo): A case report of 50 patients. Orapuh Journal. 2024.
4. Van Brusselen D, Simons E, Luendo T, Habarugira D. Improving pediatric TB diagnosis in North Kivu (DR Congo), focusing on a clinical algorithm including targeted Xpert MTB/RIF on gastric aspirates. Conflict and Health . 2020.
5. Kasai ET., Alworonga OJ., Batina AS., Juakali , SK, Adipepe BF., Ngbonda DN. Déterminants de la réponse à l'intradermoréaction à la tuberculin à Kisangani, DRC . 2016.
6. Bongo GN, Ruphine PAA, Oscar NK. Risk factors for mortality in patients with TB/HIV co-infection at the General Provincial Reference Hospital of Kinshasa, Democratic Republic of Congo. Archives of Internal Medicine Research. 2019.
7. Dieu, B.N.D., *et al.,* Nutritional Status of Tuberculous Children Diagnosed and Treated in an Urban Area in DR Congo. 2017. Open Access Library Journal, 4, e3557
8. Nikam C, Rodrigues C. Xpert MTB/RIF: The newly endorsed TB diagnostic. Pediatric Infectious Disease [Internet]. 2014 Apr 1 [cited 2025 Mar];6(2):75.
9. Available from: https://doi.org/10.1016/j.pid.2014.07.003
10. Naguthevar S, Kumar D, Ravindra A, Samantaray S, Kombade S, Bohra GK, *et al.,*341. GeneXpert Ultra for the Diagnosis of Extrapulmonary Lymphnode Tuberculosis – A Diagnostic Study from High Tuberculosis Burden Country. Open Forum Infectious Diseases [Internet]. 2022 Dec 1 [cited 2025 Mar];9. Available from: https://doi.org/10.1093/ofid/ofac492.419
11. Mani V, Paleja B, Larbi K, Kumar P, Tay JA, Siew JY, *et al.,* Microchip-based ultrafast serodiagnostic assay for tuberculosis. Scientific Reports [Internet]. 2016 Oct 24 [cited 2025 Apr];6(1). Available from: https://doi.org/10.1038/srep35845
12. Vasanthaiah S, Verma R, Kumar A, Bandari A, George J, Rastogi M, *et al.,* Culture-free whole genome sequencing of Mycobacterium tuberculosis using ligand- mediated bead enrichment method. 2024.
13. Umair M, Siddiqui SA, Farooq MA. Diagnostic Accuracy of Sputum Microscopy in Comparison With GeneXpert in Pulmonary Tuberculosis. Cureus [Internet]. 2020 Nov 8 [cited 2025 Apr]; Available from: https://doi.org/10.7759/cureus.11383
14. Chang A, Mzava O, Kounatse LAD, Lenz JS, Burnham P, Kaplinsky P, *et al.,*Metagenomic DNA sequencing to quantify Mycobacterium tuberculosis DNA and diagnose tuberculosis. Scientific Reports [Internet]. 2022 Oct 10 [cited 2025 Apr];12(1). Available from: https://doi.org/10.1038/s41598-022-21244-x
15. Rakha E, Hakeem MARA. GeneXpert MTB/RIF Assay: A Revolutionizing Method for Rapid Molecular Detection of Mycobacterium Tuberculosis in Comparison to Other Conventional Methods. International Journal of Current Microbiology and Applied Sciences [Internet]. 2017 Oct 10 [cited 2025 Mar];6(10):2573. Available from: https://doi.org/10.20546/ijcmas.2017.610.302
16. Lobia, M.M., Songs, D.G., Kampunzu, V.M., Bukaka, G.M., Sadiki, D.F., Kasai, E.T. (2025) GenXpert Positivity: A Cross-Sectional Analytical Study Carried out at the Tuberculosis Screening and Treatment Centers of Haut-Uélé. *Journal of Biosciences and Medicines*, **13**, 203-214. doi: 10.4236/jbm.2025.134018.
17. Mbala L, Nsibu NC, Mpingiyabo K. Validity of the Keith Edwards score in the diagnosis of pulmonary tuberculosis in children. Archives of Pediatrics 2013; 21:13. https://doi.org/10.1016/j.arcped.2013.10.014 .
18. Rheenen P van. The use of the pediatric tuberculosis score chart in an HIV-endemic area. Tropical Medicine & International Health 2002;7:435 . https://doi.org/10.1046/j.1365-3156.2002.00882.x .
19. Mutabazi SA, Jumanne S, Mpondo BCT, Mnzava D. Prevalence of culture positive Tuberculosis and utility of a clinical diagnostic tool for the diagnosis of Tuberculosis among HIV Infected Children attending HIV/AIDS Care and Treatment in Dodoma Municipality, Central Tanzania. International Journal of Infectious Diseases 2020;96:593. https://doi.org/10.1016/j.ijid.2020.06.001.
20. Kakinda M, Olum R, Baluku JB, Bongomin F. Diagnostic Accuracy of Clinical Diagnostic Scoring

Systems for Childhood Tuberculosis: A Systematic Review and Meta-analysis. Open Forum Infectious Diseases 2023;11. https://doi.org/10.1093/ofid/ofad624.

21. Lupande D, Kaishasha D, Mihigo C, Itongwa M, Yenga G, Katchunga P. Role of GeneXpert MTB/RIF test in the screening for pulmonary tuberculosis at the General Referral Provincial Hospital of Bukavu , in the East of the Democratic Republic of the Congo: balance after 10 months of use 2017.
22. Naguthevar S, Kumar D, Ravindra A, Samantaray S, Kombade S, Bohra GK, *et al.,*341. GeneXpert Ultra for the Diagnosis of Extrapulmonary Lymphnode Tuberculosis – A Diagnostic Study from High Tuberculosis Burden Country. Open Forum Infectious Diseases 2022;9. https://doi.org/10.1093/ofid/ofac492.419.
23. Martinson N, Hoffmann CJ, Chaisson RE. Epidemiology of Tuberculosis and HIV: Recent Advances in Understanding and Responses. Proceedings of the American Thoracic Society 2011;8:288. https://doi.org/10.1513/pats.201010-064wr.
24. Yadav R, Vaidya PC, Mathew JL, Verma S, Khaneja R, Agarwal P, *et al.,* Utility of Xpert MTB/RIF Assay for Diagnosis of Pediatric Tuberculosis Under Programmatic Conditions in India. Journal of Epidemiology and Global Health 2020;10:153. https://doi.org/10.2991/jegh.k.191215.002.
25. Baik Y, Rickman HM, Hanrahan CF, Mmolawa L, Kitonsa PJ, Sewelana T, *et al.,* A clinical score for identifying active tuberculosis while awaiting microbiological results: Development and validation of a multivariable prediction model in sub-Saharan Africa. PLoS Medicine 2020;17. https://doi.org/10.1371/journal.pmed.1003420.
26. Auguste P, Tsertsvadze A, Pink J, Court R, Seedat F, Gurung T, *et al.,* Accurate diagnosis of latent tuberculosis in children, people who are immunocompromised or at risk from immunosuppression and recent arrivals from countries with a high incidence of tuberculosis: systematic review and economic evaluation. Health Technology Assessment 2016;20:1. https://doi.org/10.3310/hta20380.