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Cognitive biases and clinical reasoning errors among medical students in a simulated leprosy case: a cross-sectional decision-tree study

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Cognitive biases and clinical reasoning errors among medical students in a simulated leprosy case: a cross-sectional decision-tree study

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Abstract

Background: Neglected tropical diseases carry a substantial global burden yet remain underrepresented in medical curricula. Leprosy poses a particular stress test for clinical reasoning: diagnosis depends on careful neurological assessment, yet training increasingly privileges imaging and laboratory investigations over bedside evaluation. We examined how medical students at different training stages reason through an atypical presentation of leprosy.

Methods: We mapped the clinical decision-making of 405 medical students from 14 Brazilian medical programmes using an interactive decision tree with 22 diverging pathways, simulating an atypical neurological presentation of leprosy. Participants were sampled across three training stages: basic sciences (n = 104), clinical clerkship (n = 101), and internship (n

= 200). Trajectories were classified into seven distinct decision-making profiles using deductive framework analysis. Associations with training stage and institutional leprosy exposure were tested using Pearson's chi-square test, the Cochran–Armitage test for trend, and Monte Carlo simulation.

Results: Only 12.8% (52/405) of participants navigated the complete target management pathway (pathway 9), with selection rates remaining low across all training stages (X^2= 0.65, p = 0.72; linear trend p = 0.51). The distribution of clinical reasoning profiles varied across the curriculum, although this overall association was exploratory (X^2 = 20.43, p = 0.059). Pre-clinical students showed an excess of cognitive-bias errors (standardised residual +2.48), whereas interns showed a deficit in these novice errors (-3.03) alongside an excess of early diagnoses followed by inappropriate management (+3.07). Most students (71.4%, 289/405) completed the case without performing the physical examination, having requested high-complexity imaging first.

Conclusions: Linear curricular progression did not inherently foster adaptive clinical problem-solving on this simulated case. Advanced training produced a pattern of confident incompetence: senior students avoided novice heuristic biases yet frequently diverged into non-guideline management regimens, a pattern consistent with technological over-reliance and automated decision-making. Developing diagnostic autonomy requires shifting from passive content accumulation toward cultivating cognitive flexibility and metacognitive awareness.

Keywords: Clinical reasoning; Medical education; Leprosy; Diagnostic errors; Cognitive bias; Curriculum; Neglected tropical diseases; Clinical simulation

Background

Clinical reasoning underpins medical practice, yet the translation of theoretical reasoning models into accurate diagnostic behaviour remains inconsistent, particularly for conditions that challenge pattern recognition and probabilistic thinking [1, 2]. The ability to navigate uncertainty and resist cognitive shortcuts becomes critical when atypical presentations defy heuristic-based approaches [3].

Leprosy constitutes a demanding stress test for clinical reasoning. Brazil carries the second-highest global burden of the disease, and diagnosis hinges on careful neurological assessment, a skill that may be eroded in clinical cultures that overvalue technological surrogates [4, 5]. The diagnostic delay associated with such errors can precipitate irreversible nerve damage and permanent disability [6].

Contemporary models of clinical reasoning distinguish between System 1 (rapid, pattern-based) and System 2 (analytical, effortful) processing. However, emerging evidence challenges the traditional assumption that diagnostic errors arise predominantly from System 1 processing; rather, “errors derive from both System 1 and System 2 reasoning” [7] and frequently originate “from lack of access to the appropriate knowledge, not from errors of processing” [7]. Croskerry’s analysis of cognitive debiasing describes similar constraints on forcing strategies: educational interventions aimed at increasing analytical processing or raising awareness of cognitive biases ‘have no impact on error rates,’ whereas approaches focused on ‘increasing application of relevant knowledge appear to have some success’ [8, 9]. Taken together, these accounts suggest that current models of diagnostic error in medical learners may underestimate the role of knowledge deficits. Students appear to develop these cognitive processes largely through self-regulated learning during the pre-clerkship phase, without formal feedback or coaching from clinician preceptors [10].

If diagnostic errors stem primarily from knowledge deficits rather than processing failures, the inability to transfer learning from pre-clinical to clinical environments becomes a critical

explanatory factor. The disconnect between basic and clinical sciences is a recognised obstacle: students consistently struggle to apply theoretical knowledge in practice, even within problem-based learning curricula [11]. This translational failure generates anxiety during the transition to clinical settings [12]. Although clinical reasoning principles are introduced during the pre-clinical stage, their practical application is often hindered by situational factors, such as limited time and supervisors unfamiliar with these concepts [13]. Pre-clinical students also score considerably lower on diagnostic justification, by margins of 30 to 48 percent, than on other clinical skills, which suggests that applying theoretical learning to practical diagnostic tasks poses a distinct challenge at this level [14]. The hidden curriculum shapes students' tolerance for diagnostic uncertainty: they acquire clinical reasoning strategies implicitly, through observation and peripheral participation in communities of practice [15, 16]. Within clinical placements, learners absorb diagnostic heuristics informally through role-modelling and workplace-based learning, developing competencies for managing uncertainty beyond the formal curriculum [17, 18].

This study addresses the gap in understanding how medical students reason through the diagnosis of leprosy within this fragmented educational landscape. By mapping clinical decision pathways using a structured decision-tree methodology, we aimed to: (1) characterise the frequency and typology of cognitive biases and reasoning errors; (2) assess whether training stage predicts diagnostic performance and characterise the typology of reasoning errors across the curriculum; and (3) identify curricular levers for remediation. These findings inform evidence-based reforms in clinical reasoning pedagogy, particularly for neglected conditions that test the limits of heuristic-dependent practice.

Methods

This cross-sectional study used a qualitative-dominant design combining structured clinical simulation with deductive framework analysis and descriptive quantification; reporting follows the STROBE recommendations for cross-sectional studies [see Additional file 2]. We conceptualised each of the 22 possible clinical pathways as a narrative unit of diagnostic reasoning—a sequential trajectory of clinical decision-making—rather than a static, categorical endpoint. These trajectories were analysed against a structured framework derived from cognitive reasoning models and refined against empirical data, allowing us to profile decision patterns across training stages. Rather than reducing performance to binary metrics of correctness, this approach captures the qualitative architecture, heuristic patterns, and procedural dynamics of clinical problem-solving.

Setting and participants

We recruited 405 medical students from 14 undergraduate medical programmes across the state of Santa Catarina, Brazil, between October and December 2024, using maximum variation sampling to ensure representation from basic sciences through to the final internship year. Distribution across training stages was 25.7% basic sciences (n = 104), 24.9% clinical clerkship (n = 101) and 49.4% internship (n = 200) (Table 1). Whilst this sampling strategy does not permit probabilistic generalisation, it supports theoretical transferability across diverse institutional contexts.

Instrument development: the clinical decision tree

We developed an interactive, branching clinical case simulating a primary care encounter with a neurological presentation of leprosy (49-year-old man, one-year history of numbness in the right fifth finger; full case in Additional file 1). The case was designed to trigger documented cognitive biases: availability bias (preference for common orthopaedic or diabetic neuropathy), anchoring (fixation on prior trauma history) and premature closure (failure to examine peripheral nerves).

The clinical architecture of the case was mapped into 22 distinct trajectories, ranging from optimal management to severe diagnostic delay. Each node forced a decision, mimicking the irreversibility of clinical commitment, and was designed to elicit cognitive pitfalls such as anchoring and premature closure. To ensure clinical authenticity and alignment with international standards, the branching framework was validated through iterative review by a panel of independent experts in infectious diseases and dermatology. This process ensured the clinical realism of the simulated sensory deficits and the robustness of the diagnostic pathways represented.

Data collection procedure

Data collection was conducted between October and December 2024 via a secure online platform custom-configured to prohibit navigational backtracking. This constraint simulated the real-time cognitive pressure and the irreversibility of clinical commitment. Upon providing electronic informed consent, participants completed a demographic survey followed by the clinical simulation. Each decision point triggered an algorithmic progression to subsequent nodes, preventing participants from revisiting prior clinical choices once a diagnostic or management commitment was made. This design ensured that the terminal pathways (1–22) reflected each learner's spontaneous heuristic application and diagnostic refinement.

The primary outcome was the terminal pathway (1–22) reached by each participant. Secondary outcomes included decision latency (time per node) and patterns of investigation requests (unnecessary imaging versus appropriate physical examination components).

Data analysis

Analysis proceeded in two integrated phases: qualitative pattern recognition followed by quantitative profiling.

Phase 1: Two investigators independently classified the 22 terminal pathways into a predefined typology of clinical reasoning patterns using a structured (framework) content-analysis approach. Categories were derived deductively from established cognitive decision-making models and refined against the data, with discrepancies resolved through consensus discussion with a third investigator. Although decision-tree simulations generate constrained choices, each pathway represents an unfolding narrative trajectory of clinical reasoning. We treated these trajectories as qualitative data to identify underlying patterns in how students prioritised diagnostic steps, formulated hypotheses, and navigated uncertainty. The 22 pathways were aggregated into seven mutually exclusive categories representing distinct decision-making profiles and investigative strategies (Table 2).

Phase 2: Quantitative profiling. We characterised the distribution of participants across the seven outcome categories by training stage. First, we examined the association between training stage and the selection of the target management pathway (pathway 9 versus all others) using Pearson's chi-square test and the Cochran–Armitage test for linear trend. Second, we assessed whether the distribution of clinical reasoning profiles differed across stages using chi-square tests with Monte Carlo simulation (10,000 replicates) because of low expected frequencies in some cells; standardised residuals were examined to identify specific deviations. Third, we tested the effect of institutional exposure (the presence of a dedicated leprosy clinic) on reaching the target pathway using chi-square tests with Yates' continuity correction. A post-hoc exploratory comparison of inappropriate management rates between internship and basic-sciences students was performed using Pearson's chi-square test. All analyses were performed in R (version 4.3.1; R Foundation for Statistical Computing, Vienna, Austria), with statistical significance set at a two-sided α of 0.05.

Trustworthiness and rigour

We employed strategies to ensure analytical rigour consistent with qualitative-dominant designs:

Credibility: triangulation between computational pathway visualisation and thematic interpretation, and peer debriefing with clinical experts in leprosy.

Dependability: audit trail documenting all analytical decisions, including coding memos and the rationale for category consolidation.

Transferability: thick description of institutional contexts and participant demographics (Table 1) to enable readers to assess applicability to other settings.

Ethical considerations

The Research Ethics Committee of Universidade do Alto Vale do Rio do Peixe (UNIARP) approved this study (CAAE: 69758523.5.0000.0259; approval number 6.166.124). The study was conducted in accordance with the Declaration of Helsinki. All participants provided electronic informed consent. Data were anonymised at collection, with no identifying information linked to clinical decision pathways.

Results

Participant characteristics

We enrolled 405 medical students from 14 distinct institutions. Demographic and academic characteristics are detailed in Table 1. The cohort was predominantly female (68.1%), and nearly half of participants (49.4%) were in their medical internship. Most students (68.6%) attended institutions without a dedicated leprosy outpatient clinic.

Table 1 Demographic and academic characteristics of participants (N = 405).

Characteristics	n (%)
Sex	
Female	276 (68.1)

Male	128 (31.6)
Prefer not to disclose	1 (0.3)
Age (years)	
Mean (SD)	24 (4.51)
Range	17 – 49
Self-reported ethnicity	
White	369 (91.1)
Pardo	28 (6.9)
Asian	6 (1.5)
Black	2 (0.5)
Stage of training	
Basic Cycle	104 (25.7)
Clinical clerkship	101 (24.9)
Internship	200 (49.4)
Dedicated leprosy outpatient clinic at the institution?	
Yes	127 (31.4)
No	278 (68.6)

196

197 **Diagnostic performance and error patterns**

198 Only 12.8% (52/405) of participants reached the optimal terminal node, characterised by both
199 timely recognition and correct therapeutic classification. The remaining students followed
200 pathways leading to avoidable diagnostic delays or clinical mismanagement. The full
201 distribution of the seven outcome categories is reported in Table 2, and the corresponding
202 flow across grouped categories is depicted in the Sankey diagram (Fig. 1).

203

Table 2 Clinical outcome categories and patterns of diagnostic reasoning (N = 405)

Category	Pathways*	n (%)	Cognitive pattern	Clinical consequence
1. Delayed diagnosis with inappropriate management	1, 2, 13, 15, 17–19, 21	101 (24.9)	Excessive reliance on investigations; failure to synthesise clinical findings.	Permanent sequelae (e.g., claw hand, foot deformity); multiple unproductive referrals.
2. Diagnostic error due to cognitive bias	3–7, 12	86 (21.2)	Availability bias; anchoring bias on prior trauma; overlooking	Incorrect alternative diagnosis (e.g., diabetes, orthopaedic pathology);

			peripheral neuropathy.	inappropriate treatment.
3. Early diagnosis with inappropriate management	8, 10	66 (16.3)	Theoretical knowledge preserved, but poor translation into practice.	Risk of monotherapy and/or insufficient treatment duration.
4. Early diagnosis with appropriate management	9	52 (12.8)	Correct hypothetico-deductive reasoning; focused, effective physical examination.	Appropriate resolution without sequelae.
5. Early clinical suspicion with diagnostic uncertainty	11	49 (12.1)	Pattern recognised but reduced clinical confidence.	Referral to a specialist referral centre; delayed treatment.
6. Late clinical suspicion with diagnostic uncertainty	16, 22	30 (7.4)	Late clinical suspicion associated with decisional hesitation.	Delayed diagnosis only marginally mitigated by referral.
7. Delayed diagnosis with inappropriate diagnostic work-up	14, 20	21 (5.2)	Correct final diagnosis, but only after excessive ordering of high-complexity investigations.	Established sequelae despite a correct but delayed diagnosis.

*Pathways correspond to the numbered routes in the decision tree (see Additional file 1).

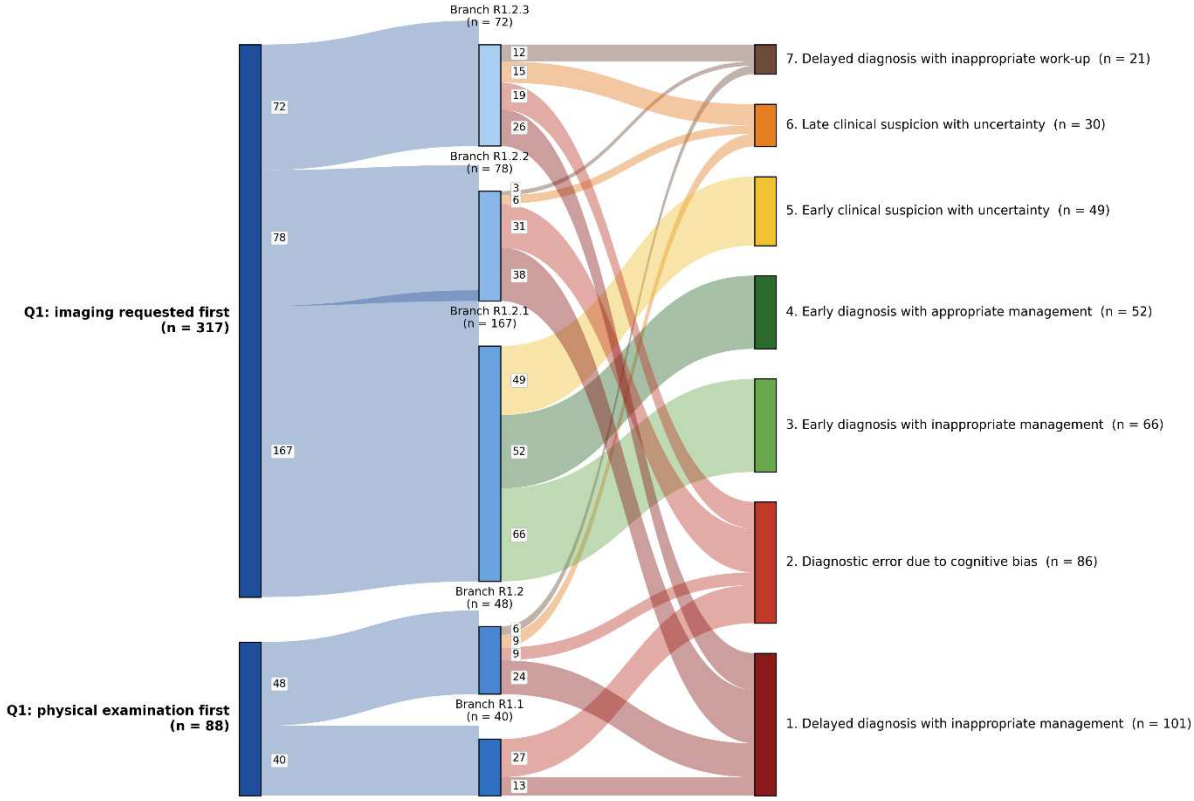


Fig. 1 Flow of 405 medical students through the decision tree into outcome categories.

Training stage and the evolution of clinical reasoning patterns

The selection of the target management pathway (pathway 9) did not differ significantly across training stages (χ^2 = 0.65, df = 2, p = 0.72), with no evidence of a linear trend (Cochran–Armitage Z = 0.65, p = 0.51). Selection of this comprehensive pathway remained infrequent across all cohorts: 10.6% (11/104) in basic sciences, 13.9% (14/101) in clinical clerkship, and 13.5% (27/200) in internship (Fig. 2).

The distribution of participants across the seven decision-making categories varied across the curriculum, although this overall association did not reach conventional statistical significance (χ^2 = 20.43, df = 12, p = 0.059); the standardised residuals reported below are therefore exploratory and hypothesis-generating. Pre-clinical students showed a higher-than-expected concentration in heuristic-driven pathways (standardised residual +2.48). Conversely, interns were less represented in these early heuristic pathways (residual −3.03), showing instead an excess in trajectories characterised by prompt diagnostic recognition

followed by divergent management strategies (residual +3.07). Clinical clerkship students occupied an intermediate position, with decision patterns aligning closely with expected distributions across categories (residuals < 1.5).

Among interns, 22.0% (44/200) followed a trajectory involving early clinical recognition coupled with non-guideline management regimens (such as discordance between paucibacillary and multibacillary protocols) or secondary investigative detours, compared with 10.6% (11/104) of basic-science students. In a post-hoc exploratory comparison, this distributional difference reached statistical significance (χ^2 = 6.02, df = 1, p = 0.014). Institutional exposure to leprosy (presence of a dedicated outpatient service) was not significantly associated with target pathway selection (χ^2 = 2.37, df = 1, p = 0.12).

Mechanisms underpinning failures in clinical reasoning

At the initial decision node, 78.3% (317/405) of students requested immediate high-cost imaging rather than proceeding to the physical examination; of these, 28 returned to the physical examination at the subsequent decision point, so that 71.4% (289/405) completed the case without performing the fundamental neurological examination. This preference for technological confirmation over physical assessment was constant across all training stages.

Within the "diagnostic error due to cognitive bias" category (n = 86), three distinct subpatterns emerged:

- **41.9% (n = 36)** anchored the diagnosis exclusively on prior trauma (a lorry accident at age 32), despite an incompatible timeline (symptoms began 17 years after the event);
- **34.9% (n = 30)** attributed the neuropathy to diabetes mellitus despite no supporting history or evidence of hyperglycaemia;

- **23.2% (n = 20)** referred patients to orthopaedics with a diagnosis of carpal tunnel syndrome or radiculopathy, without an adequate physical examination.

Interns more frequently reached an early diagnosis with inappropriate management (22.0% in internship, 10.9% in clinical clerkship and 10.6% in basic sciences). Although they recognised leprosy early, they often selected regimens for the wrong clinical form (paucibacillary versus multibacillary), without explicit mechanistic reasoning about the disease.

Figure 2 shows the distribution of outcome categories across the three stages of training. Contrary to the hypothesis of linear improvement with progression through training, the pattern was non-linear.

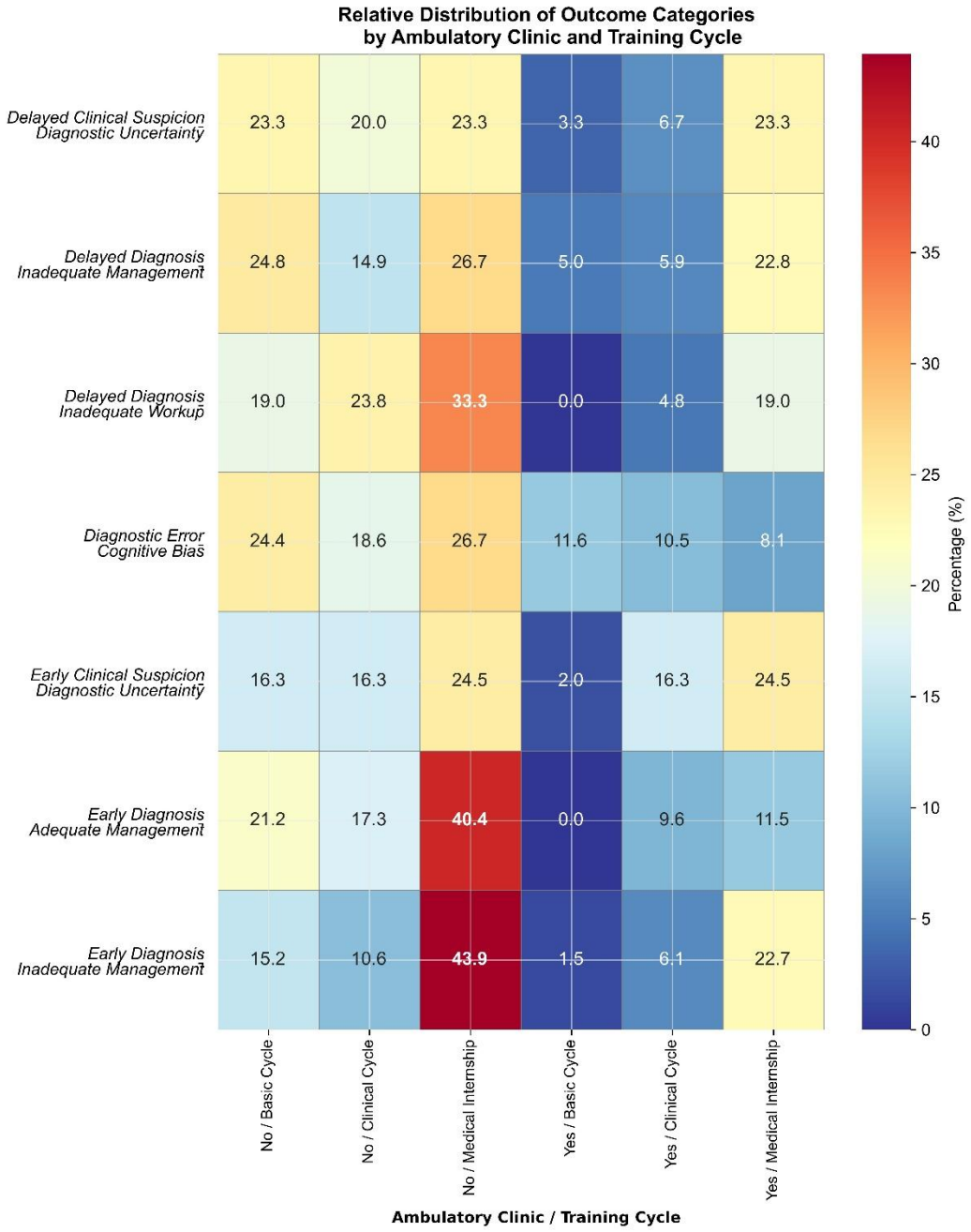


Fig. 2 Distribution of outcome categories across training stages in the leprosy decision tree.

Delayed diagnosis with inappropriate management remained frequent at every stage (28.85%, 20.79% and 25.0% respectively), suggesting that reliance on referrals and investigations reflects a structural shortcoming in medical education rather than inexperience alone. Combined, categories 5 and 6 (clinical suspicion with diagnostic uncertainty) accounted for 19.5% (n = 79) of the total sample. These students correctly formulated leprosy as the leading hypothesis, yet consistently chose referral to specialist centres rather than initiating treatment.

Qualitative review of pathways 11, 16 and 22 showed that deferral to a specialist recurred even when all clinical criteria for diagnosis and treatment were met. This pattern points to a deficit in clinical self-efficacy, which is concerning given that these future physicians will practise in primary care, where competence in initial assessment and management is essential.

Discussion

Our findings point to a paradox: four years of clinical training did not yield diagnostic proficiency on this task but changed how students failed. Novices were trapped by classic cognitive biases such as anchoring and premature closure, whereas interns showed a pattern we describe as confident incompetence: pattern recognition divorced from therapeutic rigour. We use this term as an interpretive label for the configuration observed in our data, in which early diagnostic success is coupled with systematic management errors, and we anchor it in the literature on overconfidence in clinical decision-making [25]. The pattern challenges the assumption that medical education reliably produces proficient diagnosticians through accumulated exposure [19–22].

The absence of linear improvement in diagnostic accuracy (10.6% to 13.5%, $p = 0.72$) suggests that the traditional curriculum does not, by itself, bridge the transfer gap between theoretical knowledge and clinical application for neglected conditions. Contrary to the expectation that System 1 pattern recognition improves with exposure [1, 9, 23], students did not appear to develop accurate illness scripts for a low-prevalence disease spontaneously. Instead, many relied on what might be called negative knowledge: knowing what is common, such as diabetes or trauma, to the exclusion of what is critical, such as peripheral neuropathy of infectious aetiology. This is consistent with Norman and Eva's contention that diagnostic

failure stems less from processing errors than from deficits in accessible, contextualised knowledge [24].

Beyond the stable proportion of students following the target pathway, the qualitative redistribution of decision profiles across training stages reveals a notable developmental shift. The excess of early diagnosis with inappropriate management among interns (residual +3.07) is consistent with learners capable of triggering prompt diagnostic closure but struggling to calibrate therapeutic execution [25]. This diagnostic–therapeutic gap aligns with automation bias: while senior students successfully identified the diagnostic entity, their reasoning trajectory diverged during management - a pattern plausibly rooted in curricula that prioritise algorithmic compliance over mechanistic, pathophysiological reasoning. One possible explanation is that advanced students increasingly rely on external decision heuristics or protocolised shortcuts, although technology utilisation was not directly measured in this study. Crucially, the concurrent reduction in cognitive-bias errors among interns (residual −3.03) may therefore reflect a transition between different cognitive shortcuts rather than a genuine maturation of diagnostic autonomy.

Institutional exposure to leprosy showed no detectable association with diagnostic accuracy ($p = 0.12$). The study may have been underpowered for this comparison, so a modest protective effect can be neither confirmed nor excluded. Even so, the null result is compatible with the view that mere legitimate peripheral participation [26] is insufficient for mastering neglected tropical diseases without structured pedagogical integration. The recurrent deferral observed in pathways 11, 16 and 22, in which students had met the clinical criteria for leprosy yet preferred specialist confirmation, suggests a learned culture of defensive practice in which uncertainty is managed by delegation rather than by cognitive engagement. Coupled with the 71.4% preference for immediate imaging over physical examination, this

fragmentation between classroom knowledge and clinical action suggests that current training may foster dependence on referral rather than diagnostic autonomy.

These findings call for a reconceptualisation of how diagnostic reasoning is taught for atypical presentations, with greater weight on cognitive flexibility than on content accumulation [27]. Three interventions follow from our data. First, sentinel cases of neglected diseases could be integrated into curricula as diagnostic stress tests. Second, simulation protocols could withhold access to investigations until a clinical justification is articulated, countering premature recourse to technology, sometimes termed Sutton's slip. Third, assessment rubrics could weight management reasoning as heavily as the diagnostic label itself. The hidden curriculum also matters: rather than modelling referral as the default response to uncertainty, preceptors could verbalise their own diagnostic calibration and management reasoning.

The capacity to reason through presentations that defy conventional heuristics, what might be called a health system's epistemic resilience, is a sensitive marker of training quality. Training should produce clinicians able to tolerate uncertainty without reflexively reaching for imaging or referral. For neglected diseases such as leprosy, this is a matter of patient safety as much as of educational equity.

Limitations

Several limitations should be acknowledged. First, the use of a single simulated clinical vignette, although methodologically deliberate, constrains external validity: decision-making within a structured branching tree may not fully replicate reasoning under the time pressure, affective load, and information ambiguity of authentic clinical encounters. Second, recruitment relied on maximum-variation sampling across institutions within a single Brazilian state, which supports analytical and theoretical transferability but precludes

probabilistic generalisation to the broader student population. Third, the cross-sectional, between-subjects design compares cohorts at different training stages rather than tracking the same learners longitudinally; inferences regarding the developmental trajectory of diagnostic reasoning are therefore inferential rather than observational over time. Fourth, the primary observation regarding the redistribution of clinical reasoning profiles across training stages is based on an omnibus association that did not reach the conventional significance threshold ($X^2 = 20.43$, df = 12, $p = 0.059$); the accompanying standardised residuals are exploratory and post-hoc, meaning these patterns should be regarded as hypothesis-generating and warrant verification in adequately powered, prospective studies. Finally, the self-report and reflective components remain susceptible to social-desirability and self-selection biases, which may have influenced the qualitative accounts.

Conclusions

Leprosy served as a revealing stress test for the cognitive architecture of medical training. Linear progression through the curriculum did not inherently foster adaptive clinical problem-solving, with only 12.8% of participants successfully navigating the target management pathway. Advanced learners displayed a pattern of confident incompetence: while they successfully bypassed the early heuristic traps common among novices (such as anchoring and availability biases), they more frequently diverged into non-guideline therapeutic regimens, a trajectory consistent with technological over-reliance and automated decision-making. These reasoning patterns were systematic rather than random, pointing to training models that privilege static content accumulation over cognitive flexibility and metacognitive autonomy.

The practical implications include embedding sentinel cases of neglected diseases as compulsory longitudinal assessments, structuring simulation environments to require rigorous clinical justification before unlocking high-complexity diagnostic tests, and implementing deliberate-reflection protocols that demand explicit articulation of alternative hypotheses. Because the observed redistribution of clinical reasoning profiles across training stages is exploratory, these proposals remain hypothesis-generating and warrant prospective validation. Cultivating the capacity to reason through presentations that defy routine algorithmic heuristics is essential for safeguarding patient outcomes in increasingly technology-driven healthcare environments.

List of abbreviations

EMG: electromyography; MRI: magnetic resonance imaging.

Declarations

Ethics approval and consent to participate. This study was approved by the Research Ethics Committee of the Universidade do Alto Vale do Rio do Peixe (UNIARP) (CAAE: 69758523.5.0000.0259; approval number 6.166.124) and was conducted in accordance with the Declaration of Helsinki. All participants provided electronic informed consent prior to enrolment, and data were anonymised at collection.

Consent for publication. Not applicable. The manuscript contains no individual person's identifiable data, images or clinical details; the clinical scenario used in the simulation is fictional.

Availability of data and materials. The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests. The authors declare that they have no competing interests.

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Authors' contributions. BV: conceptualisation, methodology, investigation, formal analysis, writing – original draft. MACF: clinical expertise, writing - review and editing. Both authors approved the final version.

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Use of Artificial Intelligence (AI) and AI-assisted technologies. No large language models or AI tools were used in the study design, data collection, or data analysis. Kimi K3 (Moonshot AI, version accessed August 2026) and Google Gemini (Google LLC, Mountain View, CA, USA) were used solely to improve British English grammar, wording, and textual fluency. Following this assistance, the authors reviewed and edited the manuscript and take full responsibility for the integrity and accuracy of the content.

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Additional files

Additional file 1. Format: PDF. ***Title:*** Clinical decision-tree simulation case. ***Description:*** full branching clinical case (22 pathways) used in the simulation, including all decision nodes and terminal pathways.

Additional file 2. Format: DOCX. ***Title:*** STROBE checklist for cross-sectional studies. ***Description:*** completed STROBE checklist indicating where each recommended item is reported in this manuscript.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile2STROBEchecklist.docx
- Additionalfile1.docx