

DISCREPANCIES BETWEEN PREDICTED AND ACTUAL TREATMENT OF MAXILLARY CANINE IMPACTION BASED ON THE CBCT-MCI GUIDELINE

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ABSTRACT

This study aimed to explore discrepancies between CBCT-based predicted treatment, using the CBCT-MCI guideline, and actual clinical outcomes, as well as to identify factors associated with these discrepancies in maxillary impacted canines (MICs). A retrospective analytical study was conducted on 100 MICs with pre-treatment CBCT imaging and documented treatment outcomes. Each case was evaluated using the CBCT-MCI guideline, which comprises 10 radiographic items used to generate a cumulative score and predict treatment modality. Predicted treatment was compared with actual treatment, and cases were categorized into agreement and disagreement groups. The results showed that 53% demonstrated agreement, while 47% showed disagreement between predicted and actual treatment outcomes. The CBCT-MCI guideline consistently overestimated treatment severity, with all cases classified as surgical removal. Chi-square analysis demonstrated that several CBCT sub-items were significantly associated with agreement, including palatal position ($p = 0.048$), the condition of the primary canine retained with root resorption ($p = 0.006$), missing primary canine ($p = 0.044$), and the relationship to the nasal cavity ($p = 0.001$), which showed the strongest association. Ankylosis-related findings were also significantly associated ($p = 0.031$). Multivariable logistic regression identified the relationship to the nasal cavity as the only independent predictor of disagreement ($p = 0.012$), suggesting its dominant role in prediction error. These findings indicate that while the CBCT-MCI guideline provides a structured assessment framework, it has limited discriminatory ability and may not fully reflect clinical decision-making. Discrepancies were influenced by specific anatomical characteristics, highlighting the need for more refined, data-driven predictive models.

Keywords: Maxillary Impacted Canine (MICs), CBCT, Treatment Prediction, Agreement, Guideline

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INTRODUCTION

Maxillary impacted canines (MICs) are among the most common eruption disturbances encountered in orthodontic practice, second only to third molars. Accurate diagnosis and appropriate treatment planning are essential, as MICs are often associated with complications such as root resorption of adjacent teeth, prolonged treatment duration, and increased treatment complexity (Ericson & Kurol, 1987; Becker & Chaushu, 2015). Traditionally, clinicians have relied on clinical examination combined with two-dimensional imaging, such as panoramic radiographs, to assess MICs. However, two-dimensional imaging techniques are inherently limited by distortion, superimposition, and the inability to accurately evaluate the bucco-palatal position of impacted canines (Ericson & Kurol, 1987; Alqerban et al., 2015).

The introduction of cone-beam computed tomography (CBCT) has significantly enhanced the diagnostic process by providing three-dimensional visualization of MICs. This allows for more precise assessment of spatial position, angulation, and proximity to adjacent anatomical structures, particularly in complex cases (Rossini et al., 2012; Eslami et al., 2017). As a result, CBCT has become an important adjunct in orthodontic diagnosis and treatment planning.

In response to the need for structured and clinically applicable assessment tools, several indices and guidelines have been proposed to assist clinicians in evaluating MIC severity and planning treatment (Kau et al., 2009; Pitt et al., 2006; Counihan et al., 2013). Among these, the CBCT-MCI guideline introduced by Alhummayani and Mustafa (2021) represents a simplified CBCT-based scoring system incorporating 10 radiographic parameters to predict treatment modality. The authors reported high reliability and substantial agreement between predicted and actual treatment outcomes, suggesting potential clinical applicability (Alhummayani & Mustafa, 2021).

However, despite these advancements, discrepancies between predicted treatment and actual clinical outcomes continue to be observed in practice. Previous research has largely focused on evaluating the reliability and overall accuracy of such indices, while relatively little attention has been given to understanding the specific characteristics of cases in which prediction does not align with clinical reality. Importantly, real-world clinical decision-making is inherently multifactorial and extends beyond radiographic assessment alone. Clinicians often integrate additional considerations, including patient age, biological variability, feasibility of orthodontic traction, surgical accessibility, and accumulated clinical experience (Becker & Chaushu, 2015; Arriola-Guillén et al., 2019).

This creates a fundamental tension between algorithm-based scoring systems and individualized clinical judgment. While structured guidelines aim to standardize decision-making, they may oversimplify clinical reality and fail to capture the complexity of treatment planning. Furthermore, because clinicians are typically aware of CBCT findings during treatment planning, actual treatment outcomes may not be entirely independent from the radiographic parameters used in prediction, introducing potential clinical incorporation bias.

Therefore, a deeper understanding of discrepancies between predicted and actual treatment outcomes is essential. Identifying the characteristics of cases associated with agreement and disagreement may provide valuable insights into the limitations of current CBCT-based guidelines and support the development of more accurate and clinically relevant decision-making tools. Accordingly, this study aimed to investigate discrepancies between CBCT-MCI guideline-based predicted treatment and actual clinical outcomes in MICs, and to identify factors associated with these discrepancies.

LITERATURE REVIEWS

The management of maxillary impacted canines (MICs) remains a complex clinical challenge due to the variability in anatomical presentation and treatment response. Several key factors, including the spatial position of the impacted canine, angulation, depth of impaction, and

relationship to adjacent structures, have been consistently identified as critical determinants influencing treatment decisions (Ericson & Kurol, 1987; Alqerban et al., 2015). Traditionally, these parameters were assessed using two-dimensional imaging; however, such methods are limited in their ability to fully represent the three-dimensional nature of canine impaction.

The introduction of cone-beam computed tomography (CBCT) has significantly improved diagnostic accuracy by enabling three-dimensional visualization of impacted canines. CBCT allows for precise evaluation of bucco-palatal position, root proximity, and associated pathological conditions, which are often difficult to assess using conventional radiography (Rossini et al., 2012; Eslami et al., 2017). Consequently, CBCT has become increasingly integrated into orthodontic assessment protocols for MICs.

To standardize assessment and support treatment planning, several indices and guidelines have been developed. The KPG index, introduced by Kau et al. (2009), represents one of the earliest CBCT-based systems designed to evaluate the three-dimensional position of impacted canines. Similarly, Pitt et al. (2006) proposed a treatment difficulty index based on selected clinical and radiographic factors, while Counihan et al. (2013) provided clinical guidelines for assessing impacted maxillary canines. Although these systems contribute to the understanding of impaction severity, most are primarily designed to categorize treatment difficulty rather than directly predict treatment modality.

More recently, the CBCT-MCI guideline proposed by Alhummayani and Mustafa (2021) introduced a structured scoring system incorporating ten radiographic parameters to predict treatment outcomes, including normal eruption, surgical orthodontic traction, and surgical removal. The guideline demonstrated high intra- and inter-observer reliability, as well as substantial agreement between predicted and actual treatment outcomes, suggesting its potential as a clinical decision-support tool (Alhummayani & Mustafa, 2021).

Table 1: The CBCT-MCI guide form

Items Evaluating MCI	Sub-items	Difficulty Degree
N1	Vertical	= 0
Type of impacted permanent canine	Oblique	= 1
	Horizontal	= 2
N2	Mid way	= 0
Position of impacted permanent canine	Labial	= 1
	Palatal	= 2
N3	Retained with resorbed PC roots	= 0
Corresponding of primary canine (PC)	Retained without resorbed PC roots	= 1
	Missed PC	= 2
N4	1/3 root formed	= 0
Stage of permanent canine root formation	1/2 root formed	= 1
	2/3 or Complete	= 4
N5	Away by >2 mm	= 0
Relationship of impacted permanent canine to maxillary sinus	Close by <2 mm	= 1
	In the sinus	= 10
N6	Away by >2 mm	= 0
Relationship of impacted permanent canine to nasal cavity	Close by <2 mm	= 1
	In the nasal cavity	= 10
N7	Normal <2 mm	= 0
Follicular space width of impacted permanent canine	Abnormal >2 mm	= 10
N8	Presence of PDL	= 0
Ankylosis of impacted permanent canine	Absence of PDL	= 10
N9	Away from Lateral or central incisors	= 0
Resorption of central/lateral incisors to impacted permanent canine	Resorbed roots of lateral incisor only	= 2
	Resorbed both lateral and central incisors	= 10
N10	Yes, pathological lesion	= 0
Associated pathological lesion to of impacted permanent canine	No, pathological lesion	= 10
Total Score (Sum of 10 items)	0-5=Normal spontaneous eruption of impacted canine=NE	
	>5-9=Surgical orthodontic traction of impacted canine=SOT	
	>9=Surgical extraction of impacted canine=SE	

Figure 1 The CBCT-MCI guideline proposed by Alhummayani and Mustafa (2021) indicting items and sub-items with score and evaluating decision.

Despite these advancements, treatment prediction in MIC cases remains inherently complex. Several studies have emphasized that treatment outcomes are not determined solely by radiographic severity but are also influenced by biological factors, patient age, and clinician experience (Becker & Chaushu, 2015; Arriola-Guillén et al., 2019). In borderline cases, where anatomical features do not clearly indicate a single treatment approach, discrepancies between predicted and actual outcomes may arise.

Although existing research has primarily focused on validating the reliability and accuracy of CBCT-based guidelines, there remains limited understanding of the specific clinical scenarios in which prediction fails to correspond with actual treatment outcomes. This gap is particularly important because algorithm-based scoring systems may not fully capture the multidimensional nature of clinical decision-making. In practice, orthodontists integrate radiographic findings with additional contextual factors, including patient-specific considerations, treatment feasibility, and expected biomechanical response.

Furthermore, because treatment decisions are made in a clinical setting where CBCT information is readily available, actual treatment outcomes may be partially influenced by the same radiographic parameters used in predictive models. This introduces the possibility of clinical incorporation bias, which may affect the interpretation of agreement between predicted and actual treatment.

In addition, cumulative scoring systems may disproportionately weight certain radiographic features, potentially leading to overestimation of treatment severity. Such weighting structures may favor more invasive treatment options, even in cases where less invasive approaches remain clinically feasible. This highlights a fundamental limitation of guideline-based prediction models, particularly when applied as standalone decision-making tools.

Therefore, the discrepancy between predicted and actual treatment outcomes reflects not only methodological limitations of existing scoring systems but also the inherent tension between standardized algorithms and individualized clinical judgment. A better understanding of these discrepancies is essential for refining CBCT-based guidelines and improving their clinical applicability.

RESEARCH METHODOLOGY

This study was designed as a retrospective analytical study to investigate the factors associated with agreement and disagreement between CBCT-based predicted treatment and actual clinical outcomes in patients with maxillary impacted canines (MICs).

The study sample consisted of 100 MICs with pre-treatment CBCT imaging and complete clinical records of treatment outcomes. MICs were collected from Radiology Department at Prince of Songkla University and the Dental Department at Kanchanadit Hospital in Suratthani. Inclusion criteria included the presence of unilateral or bilateral MICs, availability of CBCT images prior to treatment, and clearly documented treatment outcomes. MICs with incomplete records, poor image quality, or previous orthodontic or surgical interventions affecting the MICs were excluded.

Each MIC was evaluated using the CBCT-MCI guideline developed by Alhummayani and Mustafa (2021). This guideline includes 10 radiographic parameters that assess the position, severity, and relationship of the MICs to surrounding anatomical structures. Each parameter is assigned a score, and the total score is used to predict the most appropriate treatment modality, categorized as normal eruption, surgical orthodontic traction, or surgical extraction.

The predicted treatment obtained from the CBCT-MCI guideline was compared with the actual treatment recorded. Based on this comparison, MICs were classified into two groups: agreement, where the predicted treatment corresponded with the actual treatment, and disagreement, where the predicted treatment differed from the actual outcome.

Comparative statistical analyses were performed to evaluate differences between the agreement and disagreement groups. Chi-square tests were used for categorical variables. In addition, multivariable logistic regression analysis was conducted to identify factors associated with disagreement between predicted and actual treatment outcomes. Statistical significance was set at $p < 0.05$.

All data were analyzed using statistical software, and the results were presented in descriptive and analytical formats to address the study objectives.

RESEARCH RESULTS

The agreement of actual treatment and predicted value

Table 1 Comparison between CBCT-MCI predicted treatment and actual treatment outcome

Actual Treatment	Predicted NE	Predicted AE	Predicted SR	Total
AE	0	0	47	47
SR	0	0	53	53
Total	0	0	100	100

Note: NE is normal eruption, AE is artificial eruption or surgical orthodontic traction, SR is surgical removal or surgical extraction.

Table 2 Agreement between predicted and actual treatment

Outcome	n (%)
Agreement	53 (53%)
Disagreement	47 (47%)

The agreement between CBCT-based predicted treatment, derived from the CBCT-MCI guideline, and actual treatment outcomes was first evaluated to address the primary objective of this study. Overall, 53 out of 100 MICs (53%) showed agreement between the predicted and actual treatment outcomes, whereas 47 MICs (47%) showed disagreement. This finding indicates that the agreement was only moderate, and that discrepancies occurred in nearly half of the sample.

Chi-square analysis demonstrated no significant association between predicted and actual treatment outcomes ($\chi^2 = 0.00$, $p = 1.00$), suggesting that the CBCT-MCI scoring-based prediction did not reliably correspond with clinical treatment decisions in this dataset.

Association between individual CBCT sub-items and agreement between predicted and actual treatment outcome

To further explore which case characteristics were associated with agreement between CBCT-MCI predicted and actual treatment outcomes, chi-square analysis was performed for individual CBCT sub-items against agreement status (agree vs disagree).

Among the evaluated sub-items, several variables demonstrated statistically significant associations with agreement. These included palatal position ($p = 0.048$), the condition of the corresponding primary canine, particularly retained with root resorption ($p = 0.006$) and missing primary canine ($p = 0.044$), and the relationship of the impacted canine to the nasal cavity ($p = 0.001$), which showed the strongest association. In addition, ankylosis-related findings, represented by the presence of periodontal ligament ($p = 0.031$), were also significantly associated with agreement.

Taken together, these findings suggest that discrepancies between predicted and actual treatment outcomes are not randomly distributed but tend to occur in cases with specific anatomical and developmental characteristics, particularly those related to spatial position and biological status of the dentition.

Table 3 Chi-square analysis of Agreement associated with CBCT sub-items

Variable	Description	p-value
I11	Vertical type	0.086
I12	Oblique type	0.892
I13	Horizontal type	0.057
I21	Midway position	0.680
I22	Labial position	0.134
I23	Palatal position	0.048*
I31	Retained PC with resorbed roots	0.006**
I33	Missing primary canine	0.044*
I41	1/3 root formation	0.098
I42	1/2 root formation	0.932
I43	$\geq 2/3$ root formation	0.215
I51	Away from sinus	0.385
I52	Close to sinus	0.638
I61	Away from nasal cavity	0.349
I62	Close to nasal cavity	0.129
I63	In nasal cavity	0.001**
I71	Normal follicle	0.517
I81	PDL present	0.031*
I82	PDL absent (ankylosis)	0.158
I91	No resorption	0.902
I92	Lateral incisor resorption	0.902
I101	Pathology present	0.344

* $p < .05$: Significant (typically a 95% confidence level) ** $p < .01$: Highly significant (99% confidence level).

Specifically, MICs were located within the nasal cavity and with retained primary canine with resorbed root were highly significantly associated with agreement between actual treatment outcome and predicted treatment. In addition, the presence of palatal position of impacted permanent canine, missing primary canine, and periodontal ligament present also showed a statistically significant association with agreement of treatment modality.

Multiple Logistic Regression

Multiple logistic regression analysis using a forward stepwise (likelihood ratio) method was performed to identify factors associated with treatment outcome (AE vs SR). The overall model was statistically significant ($\chi^2 = 19.651$, $p < 0.001$), indicating that the selected variables contributed to the prediction of treatment modality.

Table 4. Final multiple logistic regression model of agreement between actual treatment outcome and predicted treatment outcome

Variables	B	OR	p-value
relationship of impacted permanent canine to nasal cavity: In the nasal cavity	-2.698	0.066	0.012

Model summary: Omnibus $\chi^2 = 26.67$, $p < 0.001$; Nagelkerke $R^2 = 0.193$

The logistic regression model was statistically significant ($\chi^2 = 26.668$, $p < 0.001$), indicating that the included variables collectively improved the prediction of agreement between CBCT-MCI predicted and actual treatment outcomes. The model explained approximately 12.5% to 19.3% of the variance, as indicated by Cox & Snell R^2 and Nagelkerke R^2 , respectively.

Although the explanatory power of the model was moderate, it reflects the multifactorial nature of clinical decision-making in maxillary impacted canine management.

Among the evaluated variables, only the relationship of the impacted canine to the nasal cavity (I63) remained a significant predictor ($p = 0.012$). The negative coefficient indicates that cases with nasal cavity involvement were more likely to be associated with disagreement. Other variables that showed significance in chi-square analysis did not retain statistical significance in the multivariable model.

The findings of this study addressed both study objectives. First, discrepancies between CBCT-based predicted and actual treatment outcomes were observed in nearly half of MICs, indicating that agreement was moderate. MICs with disagreement were characterized by more complex anatomical features and borderline presentations. Second, specific CBCT-derived variables, particularly those related to the anatomical relationship of the MICs to the nasal cavity and the condition of the primary canine, were identified as significant factors associated with these discrepancies.

DISCUSSION & CONCLUSION

The present study investigated the agreement between CBCT-MCI guideline-based predicted treatment and actual clinical outcomes in maxillary impacted canines (MICs), as well as factors associated with discrepancies between them. The findings demonstrated that the agreement between predicted and actual treatment was limited and followed a consistent pattern of misclassification rather than random variation. Overall agreement was only moderate, with nearly half of the MICs showing disagreement.

A key observation was that the CBCT-MCI scoring system consistently overestimated treatment severity, with all cases being classified as surgical removal. This lack of variability indicates that the guideline functioned as a near-deterministic classification rather than a true predictive model. Consequently, the observed agreement was driven primarily by the proportion of surgical cases in the sample rather than actual predictive performance. This finding highlights an important limitation of cumulative scoring systems, particularly when heavily weighted variables can independently determine the final outcome (Alhummayani & Mustafa, 2021).

This tendency can be explained by the structure of the CBCT-MCI scoring system. Several individual sub-items are assigned disproportionately high weights, with some features contributing up to 10 points independently. Because the threshold for surgical extraction is a total score greater than 9, the presence of even a single high-weighted feature may be sufficient to classify MIC as requiring extraction. While this approach simplifies scoring, it may oversimplify clinical reality, where treatment decisions depend on the interaction of multiple factors, including age, root development, spatial position, and overall feasibility of orthodontic traction.

One possible explanation for the guideline's tendency to overestimate treatment severity is that its scoring structure may assign disproportionate weight to certain radiographic features that appear unfavorable on CBCT, even though such features do not inevitably preclude orthodontic traction in actual practice. In contrast, clinicians may incorporate additional contextual factors, such as patient cooperation, surgical accessibility, anchorage planning, and expected biomechanical feasibility, which are not fully captured by the scoring system. Thus, the discrepancy observed in this study may not necessarily indicate that the guideline is clinically useless, but rather that it functions as a simplified decision-support tool.

Chi-square analysis revealed that several CBCT sub-items were significantly associated with agreement, including palatal position, the condition of the primary canine (particularly retained with root resorption and missing primary canine), the relationship to the nasal cavity, and ankylosis-related findings. Among these, the relationship to the nasal cavity showed the

strongest association. These findings suggest that treatment discrepancies are influenced by multiple anatomical factors, particularly those related to spatial position and biological status of the dentition. This is consistent with previous studies indicating that the position and severity of impaction play a critical role in treatment planning (Becker & Chaushu, 2015; Alqerban et al., 2015).

Another important finding was that several CBCT sub-items were not significantly associated with either treatment outcome or agreement status. This does not necessarily imply that these variables lack clinical importance. Rather, some features may be difficult to reliably identify on CBCT or may occur infrequently, limiting their statistical detectability. Furthermore, CBCT-based assessment alone cannot capture all relevant aspects of treatment decision-making, such as patient age, treatment feasibility, and clinician experience, which have been shown to influence outcomes (Arriola-Guillén et al., 2019; Rossini et al., 2012; Eslami et al., 2017).

An additional and highly informative finding was observed when analyzing predicted treatment outcomes. The CBCT-MCI scoring system produced a highly twisted distribution, with all MICs classified into the SR category. This lack of variability resulted in complete separation during logistic regression analysis, preventing meaningful model estimation. Statistically, this indicates that the predicted outcome behaves as a near-deterministic classification rather than a flexible predictive model. Clinically, it suggests that the scoring system may not adequately reflect the spectrum of real-world treatment decisions.

This behavior highlights an important limitation of cumulative scoring systems. While they are simple and easy to apply, they may not capture the complexity of clinical decision-making. Previous studies have emphasized that treatment planning for MIC is multifactorial and influenced by both anatomical and non-anatomical factors, including patient age, treatment feasibility, orthodontic mechanics, and clinician experience (Becker & Chaushu, 2015; Arriola-Guillén et al., 2019; Alqerban et al., 2015). Furthermore, although CBCT improves diagnostic accuracy, it does not directly determine treatment decisions (Rossini et al., 2012; Eslami et al., 2017).

Taken together, the results suggest that although the CBCT-MCI guideline is valuable as a structured assessment tool, its scoring system may limit its effectiveness as a standalone predictive model. In particular, the strong influence of certain high-weighted variables, such as nasal cavity involvement, may lead to systematic overestimation of treatment severity.

Conclusion

Within the limitations of this study, the CBCT-MCI guideline demonstrated only moderate agreement with actual treatment outcomes in MICs. Discrepancies between predicted and actual treatment were not random but were associated with specific anatomical characteristics, particularly the relationship of the impacted canine to the nasal cavity.

The scoring system showed a tendency to overestimate treatment severity and lacked the ability to reliably distinguish between cases requiring artificial eruption and those requiring surgical removal. In contrast, regression analysis based on actual treatment outcomes identified meaningful predictors and provided a more balanced representation of clinical decision-making.

These findings suggest that while the CBCT-MCI guideline is useful for organizing radiographic assessment and should be used as an adjunctive decision-support tool rather than a definitive substitute for clinical judgment. Within orthodontic training, residents should be encouraged to critically appraise guideline-based predictions, recognizing that such tools may inherently favor more invasive treatment approaches. Clinical decision-making should integrate key anatomical findings with broader patient-related and treatment-related considerations. Future research should focus on developing more refined and data-driven predictive models that better reflect real-world clinical practice.

Limitations and further study

Because treatment decisions in this study were derived from routine clinical practice, it is likely that the treating clinicians were aware of CBCT findings at the time of treatment planning. Consequently, the actual treatment outcomes may not have been entirely independent of the radiographic parameters incorporated within the CBCT-MCI guideline. This introduces the possibility of clinical incorporation bias, which should be taken into account when interpreting the observed agreement and disagreement between predicted and actual treatment outcomes. Further interpretation of the chi-square analysis provides additional insight into the role of CBCT sub-items in treatment decision-making. While a limited number of variables, particularly those related to the nasal cavity and the condition of the primary canine, demonstrated statistically significant associations with treatment outcome, the majority of CBCT sub-items were not significantly associated. This finding suggests that not all radiographic features included in the CBCT-MCI guideline contribute equally to clinical decision-making.

One possible explanation is that certain variables included in the guideline may not be consistently identifiable or reliably assessed on CBCT images. Some features, such as subtle periodontal ligament changes, early ankylosis, or minor root morphology variations, may be difficult to detect or may not be clearly distinguishable depending on image quality, resolution, and observer interpretation. As a result, these variables may not show a strong statistical association, not necessarily because they lack clinical importance, but because they are not adequately captured or quantified within the current CBCT-based assessment framework.

In addition, several CBCT sub-items may represent conditions that occur infrequently within the studied population, leading to limited variability and reduced statistical power to detect meaningful associations. This is particularly relevant for variables categorized as “not testable” in the present analysis, where insufficient case distribution prevented valid statistical evaluation.

These findings highlight an important limitation of the current study. The reliance on CBCT-derived variables assumes that all relevant anatomical and pathological features can be accurately identified and quantified from imaging alone. However, treatment decision-making for MIC is multifactorial and may involve clinical findings that are not fully represented on CBCT, such as soft tissue conditions, functional considerations, and patient-specific factors.

Future research should focus on developing more refined and clinically relevant predictive models by integrating CBCT-derived variables with additional clinical factors, such as patient age, eruption potential, and treatment feasibility. While CBCT provides valuable anatomical information, not all variables included in current guidelines can be consistently identified or demonstrate sufficient discriminatory power. Therefore, refinement of CBCT assessment criteria, including clearer definitions and standardized evaluation protocols, is recommended to improve reliability and reproducibility. Larger and more diverse study populations are also needed to validate these findings and to better assess less common anatomical features that were not statistically testable in the present study. In addition, data-driven approaches, such as regression-based or machine learning models, may offer more flexible and accurate alternatives to cumulative scoring systems, allowing key predictors to be identified empirically and better reflecting real-world clinical decision-making in MICs management.

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