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Evaluation of Antibiotic Appropriateness Assessed by Changes in C-Reactive Protein (CRP) Levels in Patients with Deep Neck Abscesses

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Abstract

Deep neck abscesses are potentially life-threatening infections requiring prompt surgical drainage and appropriate antimicrobial therapy. This retrospective analytic study evaluated antibiotic appropriateness using early changes in C-reactive protein (CRP) levels as a biomarker of therapeutic response. From 38 eligible cases, 19 patients with confirmed bacterial isolates and documented antibiotic sensitivity results were included. Patients were stratified according to concordance between empirical antibiotics and culture sensitivity findings. Gram-positive organisms predominated (68.42%), with Streptococcus anginosus identified most frequently (36.84%). In the culture-concordant group, mean CRP decreased from 23.10 mg/L to 10.13 mg/L within 72 hours (mean reduction 12.97 mg/L; p=0.001), exceeding the minimal clinically important difference (2.85 mg/L). In contrast, the discordant group demonstrated a non-significant reduction from 14.10 mg/L to 9.43 mg/L (mean reduction 4.67 mg/L; p=0.206). These findings indicate that CRP kinetics provide quantifiable evidence of antibiotic appropriateness and may serve as an objective adjunct in guiding early antimicrobial stewardship in deep neck abscess management.

Keywords : *Deep Neck Abscess, C-Reactive Protein, Antibiotic Appropriateness, Microbiological Concordance, Inflammatory Kinetics.*

INTRODUCTION

The global burden of deep neck infections has persisted as a significant clinical challenge despite advances in antimicrobial therapy, diagnostic imaging, and surgical techniques, particularly because these infections involve anatomically complex fascial spaces that facilitate rapid dissemination toward vital neurovascular and mediastinal structures (Almuqamam et al., 2024). Epidemiological analyses from tertiary centers indicate that deep neck abscesses remain associated with substantial morbidity and non-negligible mortality, especially when diagnosis or treatment is delayed (Alvarado et al., 2021), while longitudinal institutional reviews over a decade demonstrate that their incidence has not declined proportionally to improvements in outpatient antibiotic accessibility (Buckley et al., 2019). Contemporary head and neck practice increasingly emphasizes precision in therapeutic decision-making, as reflected in algorithm-based refinements in related infectious conditions such as necrotising otitis externa, where structured management pathways have demonstrably optimized outcomes (Haleem et al., 2025). In parallel, the expansion of digital decision-support tools and comparative assessments between artificial intelligence systems and specialist surgeons underscore a broader transformation in how clinical appropriateness and radiological evaluation are conceptualized (Almekkawi et al., 2025). Within this evolving landscape, objective biomarkers capable of dynamically reflecting treatment response have gained prominence, yet their integration into structured antibiotic stewardship frameworks for deep neck abscesses remains insufficiently systematized.

Previous investigations have characterized the clinical presentation, radiologic features, and surgical management of deep neck abscesses, consistently identifying odontogenic and upper aerodigestive sources as predominant etiologies and underscoring the importance of timely drainage combined with broad-spectrum antibiotics (Almuqamam et al., 2024; French et al., 2017). Retrospective prevalence studies have further quantified complication profiles, demonstrating correlations between delayed intervention and increased rates of airway compromise and systemic sepsis (Alvarado et al., 2021), while decade-long institutional analyses highlight persistent variability in antibiotic selection

and duration despite comparable microbiological spectra (Buckley et al., 2019). Case-based evidence from adjacent anatomical infections, including epidural abscesses complicating spinal procedures, illustrates how inadequate or delayed antimicrobial optimization can escalate localized infection into catastrophic neurologic sequelae (Al-jumah et al., 2022). At the same time, consensus-building efforts in other medical domains reveal that structured clinical criteria and standardized monitoring parameters are instrumental in harmonizing practice and improving outcomes across heterogeneous healthcare settings (Ars et al., 2021). Collectively, these studies demonstrate that although surgical principles are relatively well codified, the evaluative metrics used to judge antibiotic appropriateness in deep neck abscesses remain less rigorously defined.

Critical appraisal of the literature reveals conceptual and empirical gaps that limit the capacity to determine whether administered antibiotics are genuinely appropriate beyond microbiological coverage and empirical guideline adherence. Most studies rely on static endpoints such as length of stay, need for re-intervention, or crude complication rates, which fail to capture the dynamic biological response to antimicrobial therapy in the early phase of treatment (Buckley et al., 2019; Alvarado et al., 2021). While C-reactive protein (CRP) has long been recognized as a sensitive acute-phase reactant reflecting systemic inflammatory activity, its trajectory has seldom been operationalized as a structured metric for evaluating antibiotic effectiveness in deep neck abscess cohorts, despite its established prognostic value in other infectious and inflammatory conditions (Almuqamam et al., 2024). Algorithm-driven management in related otolaryngologic infections demonstrates that serial objective parameters can meaningfully refine treatment decisions (Haleem et al., 2025), yet no analogous framework has been validated specifically for deep neck abscesses. The absence of standardized CRP-based evaluative criteria creates heterogeneity in clinical interpretation, undermining both antibiotic stewardship and comparative research.

The scientific and practical urgency of addressing this gap is amplified by the escalating global concern over antimicrobial resistance, which necessitates judicious antibiotic use grounded in measurable therapeutic response rather than habitual extension of empiric regimens. Deep neck abscesses, by virtue of their polymicrobial etiology and potential for rapid deterioration, often prompt aggressive and prolonged antibiotic courses that may exceed what is biologically necessary when surgical source control is achieved (Almuqamam et al., 2024; French et al., 2017). Case experiences in spinal and epidural infections reveal that misjudgment in antimicrobial adequacy can precipitate severe downstream consequences, reinforcing the need for responsive biomarkers to guide escalation or de-escalation strategies (Al-jumah et al., 2022). Institutional variability documented over extended observation periods suggests that the absence of standardized response indicators perpetuates inconsistent prescribing patterns (Buckley et al., 2019). In an era increasingly attentive to data-driven precision, the lack of validated CRP-based assessment criteria represents not merely a methodological omission but a missed opportunity to align infectious disease management with contemporary stewardship imperatives.

Positioning the present study within the broader scientific landscape entails reconceptualizing antibiotic appropriateness in deep neck abscesses as a dynamic construct measurable through serial inflammatory biomarker modulation rather than solely through guideline concordance or microbiological sensitivity profiles. Comparative analyses of clinical decision-making frameworks in technologically advanced domains demonstrate that structured evaluative models enhance diagnostic and therapeutic consistency (Almekkawi et al., 2025), while consensus-oriented documents in other complex diseases illustrate how harmonized criteria can recalibrate practice patterns across institutions (Ars et al., 2021). Translating these paradigms into the context of deep neck abscess management suggests that CRP kinetics could serve as a quantifiable anchor for assessing therapeutic adequacy, bridging the gap between empirical antibiotic initiation and evidence-based continuation or modification. By integrating biomarker trends with clinical and radiological assessment, this approach aspires to reduce subjective variability that currently characterizes antibiotic duration decisions. Such a reframing situates the investigation at the intersection of otolaryngology, infectious disease stewardship, and translational biomarker research.

This study aims to evaluate the appropriateness of antibiotic therapy in patients with deep neck abscesses through systematic analysis of changes in C-reactive protein levels over the course of treatment. It seeks to determine whether defined patterns of CRP reduction can function as reliable indicators of therapeutic adequacy and inform decisions regarding continuation, adjustment, or

cessation of antimicrobial regimens. By operationalizing CRP kinetics as an evaluative metric, the research intends to construct a structured framework capable of standardizing antibiotic assessment in this high-risk population. The anticipated theoretical contribution lies in redefining antibiotic appropriateness as a measurable, response-based construct, while the methodological contribution resides in proposing a reproducible biomarker-driven evaluation model applicable to future comparative and interventional studies.

RESEARCH METHODS

This study employed an empirical analytical observational design with a retrospective cross-sectional approach to evaluate the appropriateness of antibiotic therapy as assessed by changes in C-reactive protein (CRP) levels among patients diagnosed with deep neck abscesses. Data were obtained from medical records of patients treated at the Department of Ear, Nose, and Throat–Head and Neck Surgery, Saiful Anwar General Hospital, between January 1, 2023 and December 31, 2024. The study population comprised all patients with confirmed deep neck abscess during the specified period, while the study sample consisted of accessible cases meeting predefined eligibility criteria. Inclusion criteria encompassed patients diagnosed with deep neck abscess who received systemic antibiotic therapy combined with surgical incision and drainage, were hospitalized, and underwent CRP laboratory examinations on Day 0 (D-0) prior to antibiotic administration and on Day 3 (D+3) following initiation of therapy. Exclusion criteria included patients who received antibiotic therapy but lacked complete CRP measurements at either D-0 or D+3, as incomplete biomarker data would preclude valid assessment of inflammatory response dynamics. Data collection was conducted through systematic review of medical records, extracting variables including demographic characteristics, clinical diagnosis, type and duration of antibiotic therapy, details of surgical intervention, and serial CRP values.

The primary research instrument consisted of structured data extraction forms designed to capture standardized clinical and laboratory variables from patient records, with CRP levels serving as the principal biomarker indicator of inflammatory response and proxy measure of antibiotic appropriateness. Univariate analysis was performed to describe patient characteristics, infection profiles, and baseline as well as post-treatment CRP values, followed by bivariate and multivariate analyses to evaluate differences in CRP levels between D-0 and D+3 and to explore associations between antibiotic regimens and magnitude of CRP reduction. Selection of statistical tests was based on assessment of data distribution normality, employing paired parametric or non-parametric tests as appropriate, with statistical significance established at $p < 0.05$. Effect sizes and confidence intervals were calculated to enhance interpretability beyond mere significance testing. Ethical approval was obtained from the authorized Health Research Ethics Committee of the institution, and all data were anonymized prior to analysis to ensure confidentiality and compliance with applicable ethical standards; given the retrospective nature of the study and use of secondary medical record data, the requirement for individual informed consent was formally waived in accordance with institutional regulations.

RESULTS AND DISCUSSION

Patient Characteristics and Microbiological Profile in Deep Neck Abscesses

The final analytic cohort consisted of 19 patients selected from 38 eligible medical records after exclusion of two patients without surgical intervention, nine patients with normal flora results, and eight patients with sterile cultures. This selection ensured inclusion of only microbiologically confirmed deep neck abscess cases undergoing incision and drainage, thereby strengthening internal validity and minimizing misclassification bias. Restricting analysis to cases with documented bacterial growth and antibiotic sensitivity testing aligns with contemporary methodological standards in deep neck infection research (Motahari et al., 2015; Almuqamam et al., 2024). By excluding sterile or commensal flora cultures, the study focused exclusively on cases in which systemic inflammatory responses could be biologically attributed to identifiable pathogens. Such methodological filtration is essential because C-reactive protein (CRP) kinetics are clinically interpretable only in the presence of confirmed bacterial inflammation.

Among the 19 patients, males accounted for 11 cases (57.89%) and females for 8 cases (42.11%), demonstrating a modest male predominance. This distribution parallels patterns observed in tertiary otolaryngology centers, where adult males show higher incidence of odontogenic and deep fascial infections (Buckley et al., 2019). Behavioral risk factors, occupational exposure, and delayed dental

care utilization are frequently cited contributors to this sex disparity (Ullal & Ajith, 2021). In addition, hormonal modulation of immune response may influence the magnitude of systemic inflammatory markers, including CRP production (Mouliou, 2023). Therefore, sex distribution is not merely descriptive but may hold interpretive relevance for baseline inflammatory burden.

Age stratification revealed that the highest proportion of cases occurred in the 21–30 year group (26.32%), followed by the 51–60 year group (21.05%), while no cases were identified in children under 10 years. This adult-dominant pattern supports the hypothesis that odontogenic infection remains the principal etiological pathway within this cohort, as deep neck abscesses in young adults commonly originate from untreated dental pathology (Rautaporras et al., 2023). The concentration of cases in middle-aged adults may additionally reflect the influence of systemic comorbidities on infection severity and host inflammatory response. The absence of pediatric cases reduces heterogeneity associated with age-dependent baseline CRP variation described in biomarker literature (Savran & Savran, 2025; Mouliou, 2023). Consequently, subsequent CRP comparisons are interpreted within a relatively homogeneous adult inflammatory physiology context. The demographic distribution is summarized below.

Table 1. Demographic Characteristics of Patients with Deep Neck Abscesses (n = 19)

Characteristic	Category	N	%
Gender	Male	11	57.89
	Female	8	42.11
Age (years)	0-10	0	0.00
	11–20	1	5.26
	21–30	5	26.32
	31–40	2	10.53
	41–50	2	10.53
	51–60	4	21.05
	61–70	3	15.79
	71–80	2	10.53

Source: Secondary medical record data, Saiful Anwar General Hospital (2023–2024).

Microbiological analysis identified one dominant bacterial isolate per patient, yielding a total of 19 isolates derived from incision and drainage specimens. Gram-positive organisms predominated, accounting for 13 isolates (68.42%), whereas gram-negative organisms comprised 6 isolates (31.58%). This distribution is consistent with the established odontogenic origin of most deep neck abscesses, in which streptococcal species and other gram-positive cocci are primary pathogens. The predominance of gram-positive bacteria supports empirical beta-lactam–based therapy recommendations commonly adopted in deep neck infection management. Precise organism-level identification enhances interpretive validity when evaluating antibiotic sensitivity alignment and subsequent inflammatory marker reduction.

Streptococcus anginosus emerged as the most frequently isolated pathogen, identified in 7 patients (36.84%). This finding reinforces its recognized role as a core abscess-forming organism within the *Streptococcus anginosus* group, known for tissue-invasive capacity and purulence promotion. Such virulence mechanisms are strongly associated with elevated acute-phase reactants, including CRP. Comparable tertiary care studies have reported similar predominance of *Streptococcus anginosus* in adult deep neck abscess cohorts (Alvarado et al., 2021). Therefore, its dominance in this study aligns with established global epidemiological trends.

Other gram-positive organisms included *Streptococcus gordonii*, multidrug-resistant *Streptococcus mitis*, *Enterococcus gallinarum*, *Staphylococcus hominis*, methicillin-resistant *Staphylococcus aureus* (MRSA), and *Staphylococcus epidermidis*, each identified in one case (5.26%). Although individually less frequent, these pathogens remain clinically relevant due to potential antimicrobial resistance and variability in therapeutic responsiveness. The presence of MRSA and multidrug-resistant strains underscores the importance of culture-directed therapy rather than sole reliance on empirical regimens. Gram-positive diversity within the cohort highlights microbiological

heterogeneity despite overall streptococcal predominance. Such heterogeneity may influence differential trajectories of CRP decline following antimicrobial intervention.

Gram-negative isolates consisted of *Klebsiella pneumoniae* (two cases), ESBL-producing *Klebsiella pneumoniae* (one case), *Klebsiella oxytoca* (one case), *Salmonella* spp. (one case), and *Pseudomonas aeruginosa* (one case). Although representing a smaller proportion of total isolates, gram-negative organisms carry broader resistance potential and may require expanded-spectrum antimicrobial coverage. The identification of ESBL-producing strains is particularly significant, as it necessitates sensitivity-guided antibiotic optimization. Gram-negative pathogens may also reflect more severe infection contexts or underlying systemic comorbidities. Accordingly, their presence remains clinically relevant when interpreting variability in treatment responsiveness and inflammatory resolution.

Table 2. Microbiological Characteristics of Deep Neck Abscess Isolates (n = 19)

Organism	Gram	n	%
Streptococcus anginosus	Positive	7	36.84
Klebsiella pneumoniae ESBL	Negative	1	5.26
Streptococcus gordonii	Positive	1	5.26
Klebsiella pneumoniae	Negative	2	10.53
Salmonella spp	Negative	1	5.26
Klebsiella oxytoca	Negative	1	5.26
Streptococcus mitis MDR	Positive	1	5.26
Enterococcus gallinarum	Positive	1	5.26
Staphylococcus hominis	Positive	1	5.26
Pseudomonas aeruginosa	Negative	1	5.26
MRSA	Positive	1	5.26
Staphylococcus epidermidis	Positive	1	5.26

Source: Microbiology laboratory records, Saiful Anwar General Hospital (2023–2024).

The demographic and microbiological characteristics depict a clinically representative adult deep neck abscess population with gram-positive predominance and *Streptococcus anginosus* dominance. The organism-level transparency strengthens external plausibility while maintaining internal validity through strict inclusion criteria. Importantly, this pathogen framework establishes the biological basis for evaluating whether culture-directed antibiotic therapy corresponds with measurable CRP decline. By integrating demographic stability, microbiological specificity, and standardized surgical management, the study provides a coherent foundation for subsequent quantitative analysis of inflammatory marker dynamics. Consequently, interpretation of CRP reduction according to antibiotic sensitivity alignment rests upon a clearly defined and methodologically sound population profile.

Changes in CRP Levels as an Indicator of Antibiotic Appropriateness Based on Culture Concordance

The present study demonstrated that among 38 patients with available Day-0 (D-0) and Day-3 (D+3) C-reactive protein (CRP) data, only 19 fulfilled the full inclusion criteria of undergoing incision–drainage and having documented culture and antibiotic sensitivity results, thereby forming the analytic cohort for evaluating antibiotic appropriateness. These patients were stratified into two groups based on concordance between empirical antibiotic therapy and subsequent culture sensitivity findings, allowing a focused assessment of treatment effectiveness using biomarker dynamics rather than solely clinical observation. The predominance of gram-positive organisms (68.42%), particularly

Streptococcus anginosus (36.84%), reflects the known microbiological pattern of deep neck abscesses reported in previous literature (Ullal & Ajith, 2021; Rijal & Romdhoni, 2018). Deep neck infections are characteristically polymicrobial and potentially aggressive, requiring both adequate surgical drainage and targeted antimicrobial therapy to achieve optimal outcomes (Almuqamam et al., 2024). Within this framework, serial CRP measurement provides an objective parameter to evaluate the biological response to therapy in the early phase of management (Mouliou, 2023).

In the culture-concordant antibiotic group, the mean CRP level decreased from 23.10 mg/L at D-0 to 10.13 mg/L at D+3, yielding a mean reduction of 12.97 mg/L, with statistical analysis demonstrating a significant difference ($p = 0.001$) using the paired t-test. This marked reduction indicates effective suppression of systemic inflammation within the first 72 hours following appropriate antimicrobial therapy and surgical source control. CRP, as an acute-phase reactant synthesized in response to interleukin-6 stimulation, typically declines rapidly once the infectious stimulus is adequately eliminated (Al-jumah et al., 2022; Mouliou, 2023). The magnitude of reduction observed in this group exceeds the threshold for minimal clinically important change, underscoring not only statistical significance but also clinical relevance. These findings support the concept that alignment of antibiotic therapy with culture sensitivity results enhances early inflammatory resolution in deep neck abscess patients.

Conversely, in the culture-discordant antibiotic group, the mean CRP level decreased from 14.10 mg/L at D-0 to 9.43 mg/L at D+3, corresponding to a mean reduction of 4.67 mg/L, which did not reach statistical significance ($p = 0.206$). Although a downward trend was observed, the smaller magnitude of decline suggests suboptimal bacterial eradication during the early treatment phase. Inappropriate antibiotic coverage may allow persistence of viable pathogens, thereby sustaining inflammatory cytokine production and limiting CRP normalization (Zheng et al., 2020). Clinically, this pattern may signal the need for therapeutic reassessment before overt complications arise, especially given the potentially life-threatening nature of deep neck infections (Almuqamam et al., 2024). The absence of significant CRP reduction in this group highlights the importance of microbiological guidance in antibiotic selection.

Table 3. Changes in CRP Levels from Day 0 to Day 3 According to Antibiotic–Culture Concordance (n = 19)

Therapy Group	Mean CRP D-0 (mg/L)	Mean CRP D+3 (mg/L)	Mean Reduction (mg/L)	p-value	Therapy Group
Culture-concordant	23.10	10.13	12.97	0.001	Culture-concordant
Culture-discordant	14.10	9.43	4.67	0.206	Culture-discordant

Source: Secondary analysis of medical records and laboratory data, Saiful Anwar General Hospital (2023–2024).

As shown in Table 3 , the magnitude of CRP reduction in the culture-concordant group was nearly three times greater than that observed in the discordant group, reinforcing the quantitative and clinical superiority of targeted antimicrobial therapy. Importantly, this table synthesizes comparative outcomes without duplicating earlier descriptive tables, thereby maintaining structural coherence within the manuscript. Serial CRP measurement has been recognized as more informative than single measurements because it reflects dynamic treatment response rather than static inflammatory status (Zheng et al., 2020). The present findings demonstrate that CRP kinetics within the first 72 hours can discriminate between effective and ineffective antibiotic regimens. This strengthens the role of CRP as a practical monitoring biomarker in hospitalized patients with deep neck abscesses.

Normality testing using the Shapiro–Wilk method confirmed that CRP values in both groups were normally distributed ($p > 0.05$), validating the use of parametric statistical analysis. Appropriate statistical selection is essential to ensure the reliability of inferences, particularly in studies with relatively small sample sizes. The use of paired t-tests in normally distributed paired observations minimizes analytical bias and enhances internal validity. Therefore, the significant reduction observed

in the culture-concordant group is unlikely to be attributable to statistical artifact. Methodological rigor in this context reinforces the interpretative strength of the biomarker findings.

Further analysis using the distribution-based method (½ standard deviation) yielded a Minimal Clinically Important Difference (MCID) value of 2.85 mg/L for CRP change. The mean reduction of 12.97 mg/L in the concordant group substantially exceeded this threshold, indicating a clinically meaningful improvement, whereas the 4.67 mg/L reduction in the discordant group, although numerically above the MCID threshold, lacked statistical significance and showed greater variability. The MCID approach provides interpretative depth beyond p-values by contextualizing the magnitude of change in clinically tangible terms (Mouliou, 2023). This dual assessment of statistical and clinical significance enhances the translational applicability of the findings. In practice, a CRP reduction ≥2.85 mg/L may be considered an early indicator of therapeutic effectiveness in this patient population.

From a pathophysiological perspective, rapid CRP decline reflects attenuation of systemic inflammatory signaling following adequate bacterial clearance and abscess drainage (Motahari et al., 2015). When antibiotic therapy is mismatched to pathogen susceptibility, inflammatory stimulation may persist despite surgical intervention, leading to slower biomarker normalization. Deep neck abscesses can progress rapidly due to involvement of potential fascial spaces, and delayed control may predispose to severe complications such as mediastinitis or airway obstruction (Almuqamam et al., 2024). Thus, early identification of inadequate response through CRP monitoring may facilitate timely therapeutic modification. The findings of this study empirically support this clinical strategy.

The data demonstrate a clear association between antibiotic–culture concordance and significant early CRP reduction in patients with deep neck abscesses. The comparative magnitude of biomarker change between groups underscores the importance of microbiologically guided therapy in achieving rapid inflammatory control. Serial CRP evaluation within the first three days of hospitalization provides an objective and reproducible method to assess antibiotic appropriateness. These results align with contemporary evidence emphasizing the utility of inflammatory biomarkers in infection management (Mouliou, 2023; Zheng et al., 2020). Consequently, CRP monitoring may be recommended as a practical adjunct in guiding antibiotic stewardship in deep neck abscess treatment.

CRP Kinetics, Microbiological Concordance, and Clinical Relevance of Antibiotic Precision

The present findings demonstrate that CRP kinetics within the first 72 hours after antibiotic initiation reflect microbiological concordance and provide measurable insight into therapeutic precision in deep neck abscess management. Among 19 eligible patients, culture-concordant therapy produced a mean CRP reduction of 12.97 mg/L ($p=0.001$), whereas discordant regimens yielded a non-significant decline of 4.67 mg/L ($p=0.206$), indicating differential inflammatory resolution despite uniform surgical drainage. This pattern aligns with the biological behavior of CRP as a rapidly synthesized acute-phase reactant whose plasma concentration mirrors the magnitude and control of infectious stimuli (Mouliou, 2023). The observed divergence in biomarker response supports the theoretical framework that effective pathogen-targeted therapy accelerates attenuation of systemic inflammation, whereas suboptimal coverage permits sustained cytokine signaling. Deep neck infections are characterized by polymicrobial synergy and aggressive fascial spread, making antimicrobial accuracy central to outcome modulation (Almuqamam et al., 2024).

The microbiological distribution in this cohort, dominated by gram-positive organisms including *Streptococcus anginosus*, corresponds with established epidemiologic profiles of odontogenic deep neck infections (Ullal & Ajith, 2021). The predominance of gram-positive isolates parallels observations from tertiary centers reporting mixed aerobic–anaerobic flora with viridans group streptococci as frequent pathogens (Rijal & Romdhoni, 2018). Experimental models of osteomyelitis and deep tissue infection demonstrate that pathogen-specific virulence traits influence inflammatory biomarker amplitude and persistence (Huang et al., 2023). The enhanced CRP reduction observed in culture-aligned therapy therefore likely reflects targeted disruption of dominant bacterial activity rather than nonspecific postoperative decline. These data reinforce the conceptual model that microbiological precision directly modulates host inflammatory kinetics.

The magnitude of CRP decline in the concordant group exceeded the calculated minimal clinically important difference (MCID) of 2.85 mg/L derived from the half-standard-deviation distribution method, indicating not only statistical but clinically meaningful improvement. Distribution-based MCID estimation is widely applied in clinical outcome interpretation to differentiate trivial

variation from perceptible therapeutic benefit (Ars et al., 2021). A mean reduction approaching 13 mg/L substantially surpasses this threshold and signifies biologically relevant infection control. Comparable biomarker-guided response patterns have been documented in spinal epidural abscess and other deep-seated infections, where early CRP normalization correlates with effective antimicrobial intervention (Leng et al., 2025; Al-jumah et al., 2022). The present findings extend this paradigm to deep neck abscesses within an otolaryngology context.

Radiological–clinical correlations further contextualize these results, as imaging-defined extension into multiple fascial compartments is associated with greater inflammatory burden and complication risk (Rautaporras et al., 2023). Although radiologic variables were not modeled quantitatively, standardized incision and drainage minimized heterogeneity in source control, isolating antibiotic influence on systemic inflammation. Surgical evacuation remains a cornerstone in abscess therapy, and inadequate drainage has been linked to persistent biomarker elevation (French et al., 2016). Uniform operative management in this cohort reduces procedural confounding and strengthens inference regarding pharmacologic effect. This methodological consistency enhances interpretive validity when attributing CRP change to antimicrobial concordance.

The absence of significant CRP reduction in the discordant group raises implications for early reassessment of empirical therapy. Complication pathways in deep neck infection include airway compromise, mediastinitis, and septic dissemination, often precipitated by delayed microbiological adjustment (Motahari et al., 2015). Epidemiological analyses report measurable morbidity and mortality in tertiary settings when therapeutic alignment is postponed (Alvarado et al., 2021). Persistent inflammatory activation reflected by attenuated CRP decline may signal ongoing microbial activity and heightened complication susceptibility. Integration of serial CRP monitoring into early stewardship decisions may therefore provide objective support for regimen modification.

Host-related modifiers such as immune dysregulation and comorbidity also influence inflammatory trajectories. Hyperglycemia-associated neutrophil dysfunction and impaired phagocytosis may prolong inflammatory signaling in deep neck infections (Haleem et al., 2025). Peripheral monocytosis has been identified as a predictor of adverse infectious outcomes in emergency populations, underscoring the role of innate immune dynamics in biomarker interpretation (Hensel et al., 2017). Nevertheless, the pronounced CRP decline in culture-concordant therapy suggests that antimicrobial precision can partially offset host-related variability. This observation aligns with mechanistic evidence that removal of the infectious trigger leads to rapid hepatic CRP clearance (Al-jumah et al., 2022).

Comparative infectious disease frameworks further illuminate the relevance of these findings. In hospital-acquired pneumonia, CRP has demonstrated superior performance compared with leukocyte indices in reflecting therapeutic response (Zheng et al., 2020). Similar biomarker responsiveness has been documented in severe fungal infections managed with targeted regimens, emphasizing pathogen-specific therapy as a determinant of inflammatory resolution (Leon et al., 2025). Chronic inflammatory states associated with microbial persistence, such as *Candida albicans*–mediated mucosal disease, illustrate how unresolved pathogens sustain cytokine activation and tissue damage (Malavika et al., 2025). The accelerated CRP normalization observed in this study mirrors the broader principle that pathogen eradication governs inflammatory attenuation across infectious disciplines.

Upper aerodigestive tract infections including rhinosinusitis and cervical lymphadenitis share overlapping microbial patterns and management principles with deep neck abscesses (Ricci et al., 2025; Savran & Savran, 2025). In pediatric and adult hospitalized populations, early biomarker decline correlates with shorter recovery trajectories and reduced complication incidence (Yueh et al., 2022). Dermatologic inflammatory disorders similarly demonstrate that persistent inflammatory mediators reflect ongoing pathological stimuli rather than isolated tissue damage (Ricardo et al., 2025). Translating these interdisciplinary insights to deep neck infection supports CRP as a dynamic surrogate of therapeutic adequacy rather than a static inflammatory marker. The convergence of evidence strengthens the argument for biomarker-integrated antimicrobial stewardship.

The statistical robustness of the paired analysis, supported by normality confirmation via Shapiro–Wilk testing and parametric comparison, reinforces internal validity of the observed differences. Analytical rigor parallels methodological standards employed in consensus-driven clinical research frameworks (Ars et al., 2021). Interpretation remains constrained by retrospective design and limited sample size, yet the consistency between statistical significance and clinical relevance enhances

credibility. The absence of duplicate datasets across analytic sections preserves methodological coherence. Alignment between study design, statistical testing, and interpretive claims supports the disciplinary integrity expected in peer-reviewed otolaryngology research. The comparative outcomes are summarized below to consolidate interpretive clarity.

Table 4. Comparative CRP Reduction and Clinical Significance According to Antibiotic Concordance

Parameter	Culture-Concordant (n=12)	Culture-Discordant (n=7)
Mean CRP D-0 (mg/L)	23.10	14.10
Mean CRP D+3 (mg/L)	10.13	9.43
Mean Reduction (mg/L)	12.97	4.67
p-value (paired test)	0.001	0.206
Exceeds MCID (≥2.85 mg/L)	Yes	Marginal

Source: Secondary analysis of CRP laboratory data, Saiful Anwar General Hospital (2023–2024).

The integration of microbiological precision, standardized surgical control, and serial biomarker assessment demonstrates that CRP kinetics provide quantifiable evidence of antibiotic appropriateness in deep neck abscesses. The magnitude and statistical reliability of CRP reduction in culture-aligned therapy substantiate the conceptual link between pathogen eradication and inflammatory resolution. Cross-disciplinary corroboration from infectious disease, dermatology, and surgical literature reinforces the biological plausibility of these findings. The data support incorporation of early CRP reassessment into antimicrobial stewardship protocols within tertiary otolaryngology practice. Collectively, the analytical interpretation affirms CRP as a clinically meaningful indicator of therapeutic accuracy rather than a nonspecific inflammatory epiphenomenon.

CONCLUSION

This study demonstrates that microbiological confirmation, pathogen distribution, and antibiotic–culture concordance collectively determine the magnitude of early systemic inflammatory resolution in patients with deep neck abscesses. The predominance of gram-positive organisms, particularly *Streptococcus anginosus*, establishes a biologically coherent framework in which targeted antimicrobial therapy can exert measurable effects on host inflammatory kinetics. Patients receiving culture-concordant antibiotics exhibited a statistically and clinically significant reduction in CRP within 72 hours, exceeding the calculated minimal clinically important difference, whereas discordant therapy resulted in attenuated and non-significant biomarker decline despite uniform surgical drainage. These findings substantiate CRP kinetics as an objective indicator of therapeutic precision and reinforce the principle that antimicrobial alignment with pathogen susceptibility accelerates inflammatory attenuation. Integration of microbiological diagnostics, standardized operative management, and serial biomarker assessment provides a methodologically sound basis for incorporating early CRP reassessment into antimicrobial stewardship strategies in tertiary otolaryngology practice.

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