Jurnal Farmasi Indonesia
Vol. 23, No. 01, May 2026, page. 1~12
ISSN: 1693-8615 , e-ISSN:2302-4291 , DOI: 10.31001/jfi.v20i1.paperID

Luaran Klinis dan Evaluasi Biaya Ceftazidim-Avibactam Pada Terapi Pneumonia didapat di Rumah Sakit dan Pneumonia akibat Pemakaian Ventilator: Tinjauan Naratif

Clinical Outcomes and Economic Evaluation of Ceftazidim-avibactam in Hospital-acquired and Ventilator-associated Pneumonia : A Narrative Review

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Article Info

Article history:
Received 11 08, 2025
Revised 01 06, 2026
Accepted 03 10, 2026

Kata kunci
Ceftazidim-avibactam
VAP
Efektivitas biaya
Luaran klinis

Keywords:
Ceftazidim-avibactam
VAP
Cost-effectiveness
Clinical outcomes

ABSTRAK

Pneumonia terkait ventilator (VAP) memiliki angka morbiditas, mortalitas, dan beban biaya kesehatan yang tinggi, terutama jika disebabkan oleh *Carbapenem-resistant Enterobacteriaceae* (CRE). Selama ini, terapi standar menggunakan meropenem atau kolistin. Namun, ceftazidime-avibactam (CAZ-AVI) muncul sebagai alternatif potensial. Tujuan tinjauan naratif ini adalah untuk menilai efektivitas klinis serta dampak ekonomis penggunaan CAZ-AVI. Penelusuran literatur dilakukan melalui basis data PubMed, ScienceDirect, Google Scholar, dan Scopus untuk publikasi dari tahun 2015 hingga Juli 2025. Studi yang memenuhi syarat meliputi uji coba acak, studi observasional, dan analisis pemodelan ekonomi yang mengevaluasi CAZ-AVI pada pasien dengan HAP/VAP atau infeksi yang disebabkan oleh organisme resisten karbapenem. Studi observasional melaporkan bahwa CAZ-AVI dikaitkan dengan penurunan angka kematian dibandingkan dengan beberapa rejimen konvensional. Analisis pemodelan ekonomi menunjukkan bahwa CAZ-AVI hemat biaya, dengan rasio efektivitas biaya inkremental (ICER) berkisar dari USD 3.317 hingga USD 35.328 per tahun kehidupan yang disesuaikan kualitas (QALY). CAZ-AVI dapat memberikan hasil klinis yang menguntungkan dan potensi nilai ekonomi dalam pengobatan HAP/VAP, khususnya pada infeksi yang disebabkan oleh organisme resisten. Namun, temuan ini sebagian besar berasal dari studi observasional dan model ekonomi. Oleh karena itu, studi klinis lebih lanjut diperlukan untuk mendefinisikan dampak klinis dan ekonominya dengan lebih baik.

ABSTRACT

Ventilator-associated pneumonia (VAP) is associated with high morbidity, mortality, and substantial healthcare costs, particularly when caused by carbapenem-resistant Enterobacteriaceae (CRE). Conventional treatment strategies have primarily relied on antibiotics such as meropenem or colistin. However, ceftazidime–avibactam (CAZ-AVI) has emerged as a potential alternative therapeutic option. The objective of this narrative review was to evaluate the clinical effectiveness and economic impact of CAZ-AVI therapy. A literature search was conducted using PubMed, ScienceDirect, Google Scholar, and Scopus for studies published between 2015 and July 2025. Eligible studies included randomized controlled trials, observational studies, and economic modeling analyses evaluating CAZ-AVI in patients with hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP), or infections caused by carbapenem-resistant organisms. Observational studies reported that CAZ-AVI therapy was associated with lower mortality compared with several conventional treatment regimens. Economic modeling analyses indicated that CAZ-AVI may be cost-effective, with incremental cost-effectiveness ratios (ICERs) ranging from USD 3,317 to USD 35,328 per quality-adjusted life year (QALY) gained. CAZ-AVI may provide favorable clinical outcomes and potential economic value in the treatment of HAP/VAP, particularly in infections caused by resistant pathogens. However, these findings are largely derived from observational studies and economic modeling analyses. Therefore, further clinical studies are required to better define its clinical and economic impact.

1. INTRODUCTION

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Ventilator-Associated Pneumonia (VAP) is a severe type of hospital-acquired pneumonia that occurs in patients undergoing mechanical ventilation for more than 48 hours [1]. It represents a major burden in intensive care units (ICUs), both clinically and economically [2]. The incidence of VAP exhibits significant variability. Epidemiological data reveal a range of incidence rates, from 2 to 16 episodes per 1,000 ventilator days, with a prevalence of approximately 18%, affecting 5-40% of patients on mechanical ventilation [3]. The mortality rates associated with VAP are particularly concerning, exceeding 30% in many cases [4]. It associated with prolonged hospital stays, elevated healthcare costs, and significant mortality, especially in resource-limited settings. Antibiotic therapy remains the cornerstone of VAP management [5]. However, the rising prevalence of multidrug-resistant (MDR) pathogens has posed significant challenges to effective treatment. Inappropriate or delayed antibiotic administration is strongly associated with poor clinical outcomes [6], [7]. Among the various antibiotic regimens, meropenem, a broad-spectrum carbapenem, and ceftazidime-avibactam (CAZ-AVI), a novel β-lactam/β-lactamase inhibitor combination, are widely used in the treatment of VAP caused by resistant Gram-negative bacteria [8].

Despite the clinical recommendations that support the use of both medications, ongoing research is underway to ascertain their comparative clinical efficacy and cost implications. In contrast to meropenem, which is frequently used as a first-line treatment but may be hampered by rising resistance rates, ceftazidime-avibactam has demonstrated robust effectiveness against carbapenem-resistant Enterobacteriaceae (Tompkins and van Duin, 2021). CAZ-AVI offers a wide range of efficacy against MDR germs by combining a non-beta-lactam beta-lactamase inhibitor with a third-generation cephalosporin [10]. The emergence of such agents offers new hope for managing VAP, particularly in settings where conventional treatments are becoming less effective. Evaluating the clinical efficacy and economic viability of CAZ-AVI is essential to guide rational antibiotic use and support health policy planning.

In recent years, several studies have evaluated the clinical outcomes and economic value of ceftazidime-avibactam in the management of nosocomial pneumonia and infections caused by carbapenem-resistant organisms. However, available evidence originates from heterogeneous sources, including randomized trials, observational studies, and economic modeling analyses conducted in different healthcare settings. A comprehensive synthesis of this evidence is needed to better understand the potential clinical benefits and economic implications of this therapy. Therefore, this narrative review aims to summarize and critically evaluate current evidence regarding the clinical outcomes and economic evaluations of ceftazidime-avibactam in the treatment of hospital-acquired pneumonia and ventilator-associated pneumonia.

2. METHODS

Study design

This study was conducted as a narrative review to summarize available evidence regarding the clinical outcomes and economic evaluation of ceftazidime-avibactam in the treatment of hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP). The review was guided by the Scale for the Assessment of Narrative Review Articles (SANRA). A literature search was conducted in four electronic databases: PubMed, Scopus, ScienceDirect, and Google Scholar. The search included studies

published between January 2015 and July 2025. Keywords used in the search strategy included "ceftazidime-avibactam," "ventilator-associated pneumonia," "hospital-acquired pneumonia," "clinical outcomes," and "cost-effectiveness." Relevant studies were identified through title and abstract screening, followed by full-text evaluation to determine eligibility.

Eligibility criteria

The inclusion criteria are studies evaluating CAZ-AVI in VAP and HAP or infections caused by carbapenem-resistant pathogens; reported clinical (e.g., mortality, clinical cure, nephrotoxicity) or economic outcomes (e.g., ICER, QALY, healthcare costs); full-text available in English, randomized trials, observational studies, or economic evaluation studies, articles published between 2015-2025. The exclusion criteria included case reports or narrative commentaries, studies that only discuss antibiotic in animal or in vitro, studies without relevant clinical or economic outcomes., not available in English.

Data Extraction

Data from eligible studies were extracted using a standardized data collection form. Extracted information included study design, country, study population, intervention, comparator, reported clinical outcomes, and economic outcomes. Findings from the included studies were synthesized descriptively.

3. RESULTS

The flowchart in Figure 1 illustrates the literature search and study selection process conducted for this narrative review, commencing with the identification of 386 records from four prominent databases: Scopus, PubMed, Google Scholar, and ScienceDirect. During the screening phase, 286 articles were excluded based on irrelevant titles, reducing the sample size to 100 articles. To ascertain the relevance of the remaining papers, they underwent a more thorough screening procedure based on their abstracts and titles. The chart also shows that 10 of these were identified as duplicates and removed from consideration. Consequently, a total of 90 full-text articles were reviewed to ascertain their eligibility for the subsequent phase. Of the 90 full-text articles assessed, 83 were excluded for various reasons, including the absence of clear clinical outcomes, language barriers (e.g., Arabic), and populations that did not meet the inclusion criteria. Five studies were identified that met all the specified requirements and were thus incorporated into the final analysis.

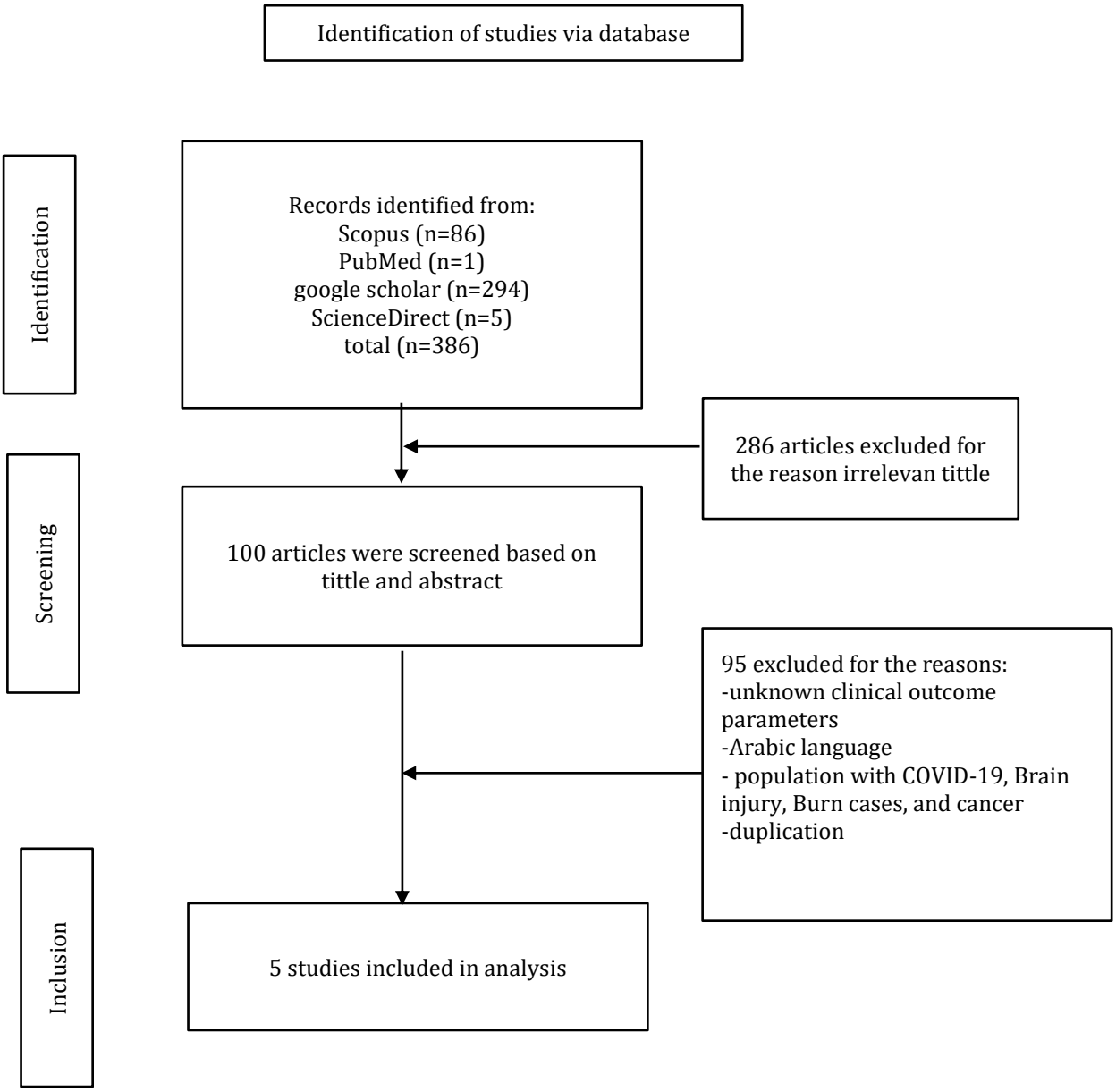

Figure 1. Literature Search and Study Selection Process for The Narrative Review

Table 1. Articles shorted by study design, Population, Clinical Outcomes, Key Findings

No	Country	Study Design	Population	Intervention	Comparator	Clinical Outcomes	Key Findings	References
1	Brazil	Economic modelling (Markov model)	Simulated adult ICU patients with CRE/CRPa VAP	CAZ-AVI	Polymyxin B	28-day mortality, nephrotoxicity	The use of CAZ-AVI has been shown to result in significantly fewer mortality and nephrotoxic events compared to polymyxin-based regimens	[11]
2	Saudi Arabia	Retrospective cohort study	157 patients with CRE	CAZ-AVI	Best Available Therapy	14-day mortality and 30-day mortality	ceftazidime-avibactam therapy was associated with a lower 14-day mortality (HR=0,46), while 30-day mortality outcomes were not significantly different between treatment groups.	[12]
3	Italy	Economic model based on RCT data	Simulated HAP/VAP patients	CAZ-AVI	Meropenem	Clinical cure, life years	Compared to meropenem followed by colistin and high-dose meropenem, ceftazidime-avibactam (CAZ-AVI) demonstrated better clinical outcomes, including a higher cure rate (72.42% vs. 58.90%), a lower in-hospital mortality rate (16.32% vs. 20.54%), and greater life-years and QALYs gained. However, a modestly elevated rate of adverse outcomes was associated with CAZ-AVI (8.66% vs. 5.02%).	[13]
4	Colombia	Economic modelling (decision tree)	Simulated patients with CRE Klebsiella	CAZ-AVI	Colistin + Meropenem	30-day mortality	CAZ-AVI reducing mortality and lowering the need for additional antibiotic therapy. In a modeled cohort of 1,000 patients, CAZ-AVI was associated with 228 fewer deaths	[14]
5	China	Economic modelling study	Simulated HAP/VAP patients	CAZ-AVI	Meropenem	Cure rate, mortality	The CAZ-AVI regimen demonstrated marginally improved clinical efficacy over the meropenem regimen, with only a modest 3.35% increase in clinical cure rate and a minimal reduction of 0.1 day in hospital stay.	[15]

4. DISCUSSION

Clinical effectiveness of ceftazidime-avibactam in HAP/VAP

Ceftazidime-avibactam (CAZ-AVI) has emerged as an important therapeutic option for the management of hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP), particularly in infections caused by multidrug-resistant Gram-negative pathogens. Evidence from randomized controlled trials and observational studies has evaluated the clinical effectiveness of this antibiotic combination in the treatment of severe nosocomial infections. The REPROVE randomized clinical trial demonstrated that ceftazidime-avibactam was non-inferior to meropenem in achieving clinical cure and mortality outcomes among patients with HAP and VAP. This finding suggests that CAZ-AVI may serve as an alternative empirical therapy in nosocomial pneumonia caused by Gram-negative bacteria, particularly in settings with increasing carbapenem resistance. However, because the trial was designed with a non-inferiority framework, it was not intended to demonstrate superiority over existing carbapenem therapy [13].

In addition to randomized trials, observational studies have reported favorable outcomes associated with CAZ-AVI in infections caused by carbapenem-resistant Enterobacterales (CRE). A retrospective cohort study conducted in Saudi Arabia reported that treatment with CAZ-AVI was associated with a significantly lower risk of 14-day mortality compared with best available therapy (BAT), with an adjusted hazard ratio of 0.45. These findings indicate that CAZ-AVI may improve survival outcomes in patients with CRE infections, although the observational nature of the study limits the ability to establish causality[12].

Overall, current clinical evidence suggests that CAZ-AVI provides clinical outcomes comparable to existing therapies and may offer additional benefits in infections caused by carbapenem-resistant organisms. Nevertheless, further prospective and real-world studies are required to better define its comparative effectiveness across different clinical settings.

Comparison with colistin-based regimens

Historically, polymyxins such as colistin and polymyxin B have been widely used for the treatment of infections caused by carbapenem-resistant Gram-negative pathogens. However, the use of these agents is often limited by significant nephrotoxicity and suboptimal clinical efficacy. Economic and clinical studies comparing CAZ-AVI with polymyxin-based regimens suggest that CAZ-AVI may provide improved clinical outcomes and safety profiles. An economic evaluation conducted in Brazil reported that CAZ-AVI therapy was associated with lower mortality and reduced nephrotoxicity compared with polymyxin B in patients with ventilator-associated pneumonia. The improved clinical outcomes contributed to increased quality-adjusted life years (QALYs), supporting the potential clinical value of CAZ-AVI despite higher drug acquisition costs[11].

Safety profile and resistance considerations of Ceftazidime-Avibactam (CAZ-AVI)

Ceftazidime-Avibactam has exhibited a favorable safety profile, particularly in comparison with traditional agents such as colistin and polymyxins, which are frequently

utilized to treat infections caused by carbapenem-resistant organisms. A notable benefit of CAZ-AVI is its reduced risk of nephrotoxicity. Colistin-based therapies, while historically standard in treating MDR-negative infections, have a well-documented history of causing acute kidney injury. This has clinical implications, particularly in critically ill patients who are already at risk for organ dysfunction [11].

CAZ-AVI is particularly efficacious in combating a wide spectrum of resistant gram-negative bacteria, including Klebsiella pneumoniae strains that produce OXA-48 and KPC carbapenemase. This property renders it a valuable instrument in microbiological research and clinical applications. These resistance mechanisms are increasingly prevalent on a global scale and they pose significant challenges, particularly in the context of VAP and other hospital-acquired infections. In Saudi Arabia, for example, OXA-48-producing *Klebsiella pneumoniae* has been indentified as predominant cause of CRE infections, highlighting the need for treatment options that can effectively overcome these enzymes. The incorporation of avibactam, a component of CAZ-AVI, results in the inhibition of Class A, C, and certain Class D β-lactamases, thereby addressing this critical therapeutic need [12].

Despite these advantages, resistance to CAZ-AVI is an emerging concern. Resistance may develop during treatment, particularly in the presence of mutations in porin proteins or upregulation of efflux pumps in some bacterial strains. However, compared to carbapenems and colistin, CAZ-AVI appears to select for resistance at a slower rate and is still effective against many strains resistant to traditional agents [15]. Antimicrobial care and continuous surveillance are therefore essential to maintain the efficacy of these medications and prevent the development of bacterial resistance.

In summary, CAZ-AVI offers a compelling combination of safety and efficacy, making it a preferred option in the treatment of severe hospital-acquired and ventilator-associated infections due to resistant gram-negative pathogens. Its lower toxicity, especially regarding renal function, along with its robust spectrum of activity against critical resistance mechanisms such as OXA-48 and KPC, reinforces its role in modern antimicrobial therapy. Nevertheless, meticulous observation of resistance patterns and judicious utilization in empirical regimens remain crucial to extending its clinical utility and preventing resistance development.

Economic evaluation and cost-effectiveness of Ceftazidime-Avibactam (CAZ-AVI)

Ceftazidime-Avibactam (CAZ-AVI) has undergone extensive evaluation for its clinical efficacy and economic value in treating HAP, including VAP. Several cost-effectiveness analyses have evaluated the economic value of ceftazidime–avibactam in patients with HAP and VAP, particularly in settings with a high prevalence of carbapenem-resistant pathogens as seen in table 2. The REPROVE trial, which demonstrated CAZ-AVI's clinical non-inferiority to meropenem, served as the basis for several economic models that examined the downstream financial implications of each treatment strategy [13]. A cost-effectiveness analysis of the treatment of carbapenem-resistant Enterobacteriaceae (CRE) was conducted in Italy. The analysis compared a typical treatment sequence of meropenem followed by colistin and high-dose meropenem with a sequence of CAZ-AVI followed by colistin and high-dose meropenem.

The model demonstrated that CAZ-AVI enhanced clinical cure rates by 13.52%, reduced hospital stay by 0.4 days per patient, and resulted in incremental gains of 0.195 life-years and 0.350 QALYs. The quality-adjusted life year (QALY) gained was shown to have an incremental cost-effectiveness ratio (ICER) of €3,581, which is substantially less than Italy's willingness-to-pay threshold of €30,000/QALY. These findings suggest that CAZ-AVI may represent a cost-effective treatment strategy within the Italian healthcare system [13].

A decision-tree economic model conducted in China evaluated the cost-effectiveness of CAZ-AVI compared with meropenem using real-world antimicrobial resistance data. The base-case analysis estimated an ICER of $35,328.2 per QALY gained, which was slightly below China's willingness-to-pay threshold of $36,598 per QALY. Sensitivity analyses demonstrated that the prevalence of antibiotic resistance substantially influenced the cost-effectiveness results, suggesting that the economic value of CAZ-AVI may be greater in settings with higher carbapenem resistance rates [15]. Economic evaluations in Latin America have also assessed the value of CAZ-AVI in treating infections caused by carbapenem-resistant organisms. In Colombia, a cost-utility analysis comparing CAZ-AVI with a colistin–meropenem regimen reported an incremental gain of 1.76 QALYs per patient and an ICER of $3,317 per QALY gained. Although this ICER slightly exceeded the national willingness-to-pay threshold of $2,438, the analysis indicated that CAZ-AVI may provide additional health benefits compared with colistin-based therapy, particularly in the context of resistant infections [14]. Similarly, a cost-effectiveness analysis conducted in Brazil compared CAZ-AVI with polymyxin B for the treatment of ventilator-associated pneumonia caused by resistant Gram-negative pathogens. The analysis estimated an ICER of BRL 35,298.65 per QALY gained. These results were partly influenced by the higher rates of nephrotoxicity and poorer survival outcomes associated with polymyxin-based therapy, which contributed to the relatively favorable economic profile of CAZ-AVI in the model [11].

Overall, current economic evidence suggests that ceftazidime–avibactam may provide economic value in the management of nosocomial pneumonia caused by multidrug-resistant pathogens. Nevertheless, these findings are largely derived from modeling studies and may depend on local epidemiological conditions, healthcare costs, and willingness-to-pay thresholds. Therefore, the economic value of CAZ-AVI should be interpreted within the context of individual healthcare systems.

This review has several limitations that should be acknowledged. First, the number of available studies specifically evaluating CAZ-AVI in VAP remains limited. Second, many of the included studies were economic modeling analyses or observational studies rather than randomized clinical trials. As a result, the findings may be influenced by modeling assumptions or potential confounding factors. Additionally, the included studies were conducted in different healthcare systems with varying antimicrobial resistance patterns and cost structures, which may limit the generalizability of the economic findings. Future research should focus on prospective real-world studies evaluating both clinical outcomes and economic impact of CAZ-AVI in diverse healthcare settings.

Table 2. Articles shorted by study design, Population, Economic Outcomes, Key Findings

No	Country	Study Design	Population (N)	Intervention	Comparator	Economic Outcomes	Key Findings	References
1	Brazil	Economic modeling (Markov model)	Simulated adult ICU patients with CRE/CRPa VAP	CAZ-AVI	Polymyxin B	QALY, ICER	CAZ-AVI has been demonstrated to be a safer and more affordable option, with an ICER BRL 35,298/QALY ratio. In 55% and 89% of the interactions in the PSA, CAZ-AVI was determined to be cost-effective, employing WTP criteria of BRL 40,000 and 120,000/QALY gained, respectively.	[11]
2	Italy	Economic modeling	Simulated HAP/VAP patients	CAZ-AVI	Meropenem	QALY, ICER	CAZ-AVI superior: +0.35 QALY; ICER €3,581/QALY	[13]
3	Colombia	Economic modeling (decision tree)	Simulated patients with CRE Klebsiella	CAZ-AVI	Colistin + Meropenem	QALY, ICER	CAZ-AVI: +1.76 QALY; ICER $3,317/QALY	[14]
4	Iran	Observational descriptive	1,395 ICU patients	Not specific	Not specific	Antibiotic cost	VAP spent €105,000 on antibiotics	[16]
5	China	Economic modeling (decision tree)	Simulated HAP/VAP patients	CAZ-AVI	Meropenem	QALY, ICER	ICER $35,328/QALY; borderline cost-effective under Chinese WTP	[15]

5. CONCLUSION

Available evidence suggests that ceftazidime-avibactam is associated with favorable clinical outcomes in the treatment of hospital-acquired and ventilator-associated pneumonia, particularly in infections caused by carbapenem-resistant organisms. Economic evaluations conducted in several countries also indicate that ceftazidime-avibactam may be a cost-effective treatment option under specific healthcare settings and willingness-to-pay thresholds. However, the current evidence base is largely derived from observational studies and economic modeling analyses. Therefore, the clinical and economic benefits of ceftazidime-avibactam should be interpreted with caution and may vary across healthcare systems. Further prospective studies and real-world evaluations are needed to better clarify its clinical effectiveness and economic value.

6. ACKNOWLEDGMENT

The author wishes to express profound gratitude to the Master Program in Clinical Pharmacy at Universitas Gadjah Mada. Expressions of profound gratitude are directed towards the academic supervisors, whose contributions have proven to be of inestimable value. Their guidance, constructive feedback, and encouragement have been instrumental in facilitating the process of writing.

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Jurnal Farmasi Indonesia
Vol. xx, No. xx, Month 20xx, page. xx~xx
ISSN: 1693-8615 , e-ISSN:2302-4291 , DOI: 10.31001/jfi.v20i1.paperID

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Article Info

Article history:
Received mm dd, yyyy
Revised mm dd, yyyy
Accepted mm dd, yyyy

Kata kunci
Ceftazidim-avibactam
VAP
Efektivitas biaya
Luaran klinis

Keywords:
Ceftazidim-avibactam
VAP
Cost-effectiveness
Clinical outcomes

ABSTRAK

Pneumonia terkait ventilator (VAP) memiliki angka morbiditas, mortalitas, dan beban biaya kesehatan yang tinggi, terutama jika disebabkan oleh *Carbapenem-resistant Enterobacteriaceae* (CRE). Selama ini, terapi standar menggunakan meropenem atau kolistin. Namun, ceftazidime-avibactam (CAZ-AVI) muncul sebagai alternatif potensial. Tujuan tinjauan naratif ini adalah untuk menilai efektivitas klinis serta dampak ekonomis penggunaan CAZ-AVI. Penelusuran literatur dilakukan melalui basis data PubMed, ScienceDirect, Google Scholar, dan Scopus untuk publikasi dari tahun 2015 hingga Juli 2025. Studi yang memenuhi syarat meliputi uji coba acak, studi observasional, dan analisis pemodelan ekonomi yang mengevaluasi CAZ-AVI pada pasien dengan HAP/VAP atau infeksi yang disebabkan oleh organisme resisten karbapenem. Studi observasional melaporkan bahwa CAZ-AVI dikaitkan dengan penurunan angka kematian dibandingkan dengan beberapa rejimen konvensional. Analisis pemodelan ekonomi menunjukkan bahwa CAZ-AVI hemat biaya, dengan rasio efektivitas biaya inkremental (ICER) berkisar dari USD 3.317 hingga USD 35.328 per tahun kehidupan yang disesuaikan kualitas (QALY). CAZ-AVI dapat memberikan hasil klinis yang menguntungkan dan potensi nilai ekonomi dalam pengobatan HAP/VAP, khususnya pada infeksi yang disebabkan oleh organisme resisten. Namun, temuan ini sebagian besar berasal dari studi observasional dan model ekonomi. Oleh karena itu, studi klinis lebih lanjut diperlukan untuk mendefinisikan dampak klinis dan ekonominya dengan lebih baik.

ABSTRACT

Ventilator-associated pneumonia (VAP) is associated with high morbidity, mortality, and substantial healthcare costs, particularly when caused by carbapenem-resistant Enterobacteriaceae (CRE). Conventional treatment strategies have primarily relied on antibiotics such as meropenem or colistin. However, ceftazidime–avibactam (CAZ-AVI) has emerged as a potential alternative therapeutic option. The objective of this narrative review was to evaluate the clinical effectiveness and economic impact of CAZ-AVI therapy. A literature search was conducted using PubMed, ScienceDirect, Google Scholar, and Scopus for studies published between 2015 and July 2025. Eligible studies included randomized controlled trials, observational studies, and economic modeling analyses evaluating CAZ-AVI in patients with hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP), or infections caused by carbapenem-resistant organisms. Observational studies reported that CAZ-AVI therapy was associated with lower mortality compared with several conventional treatment regimens. Economic modeling analyses indicated that CAZ-AVI may be cost-effective, with incremental cost-effectiveness ratios (ICERs) ranging from USD 3,317 to USD 35,328 per quality-adjusted life year (QALY) gained. CAZ-AVI may provide favorable clinical outcomes and potential economic value in the treatment of HAP/VAP, particularly in infections caused by resistant pathogens. However, these findings are largely derived from observational studies and economic modeling analyses. Therefore, further clinical studies are required to better define its clinical and economic impact.

7. PENDAHULUAN

Ventilator-Associated Pneumonia (VAP) merupakan bentuk pneumonia yang serius yang terjadi pada pasien yang menggunakan ventilasi mekanik selama lebih dari 48 jam [1]. Kondisi ini merupakan salah satu beban utama di unit perawatan intensif (ICU), baik dari sisi klinis maupun ekonomi [2]. Insidensi VAP menunjukkan variasi yang cukup besar. Data epidemiologi menunjukkan bahwa angka kejadian VAP berkisar antara 2 hingga 16 kasus per 1.000 hari penggunaan ventilator, dengan prevalensi sekitar 18%,

dan dapat memengaruhi 5–40% pasien yang menggunakan ventilasi mekanik [3]. Angka mortalitas akibat VAP juga cukup tinggi dan dalam banyak kasus dapat melebihi 30% [4]. VAP berkaitan dengan peningkatan lama rawat inap di rumah sakit, peningkatan biaya pelayanan kesehatan, serta tingginya angka kematian, terutama pada negara dengan sumber daya terbatas. Terapi antibiotik tetap menjadi dasar utama dalam penatalaksanaan VAP [5]. Namun demikian, meningkatnya prevalensi patogen *multidrug-resistant* (MDR) telah menjadi tantangan besar dalam terapi yang efektif. Pemberian antibiotik yang tidak tepat atau terlambat diketahui berhubungan kuat dengan luaran klinis yang buruk[6], [7]. Di antara berbagai regimen antibiotik yang digunakan, meropenem, suatu karbapenem spektrum luas, serta ceftazidime-avibactam (CAZ-AVI), kombinasi baru β-laktam dan β-laktamase inhibitor, banyak digunakan dalam pengobatan VAP yang disebabkan oleh bakteri Gram-negatif resisten [8].

Meskipun rekomendasi klinis mendukung penggunaan kedua obat tersebut, penelitian masih terus dilakukan untuk mengevaluasi efektivitas klinis dan implikasi biaya dari masing-masing terapi. Berbeda dengan meropenem yang sering digunakan sebagai terapi lini pertama namun menghadapi peningkatan angka resistensi, ceftazidime-avibactam telah menunjukkan aktivitas yang kuat terhadap carbapenem-resistant Enterobacteriaceae (CRE)[9]. CAZ-AVI mengombinasikan sefalosporin generasi ketiga dengan *inhibitor β-laktamase non-β-laktam* sehingga memberikan spektrum aktivitas yang luas terhadap bakteri MDR [10]. Kehadiran agen baru ini memberikan harapan baru dalam penatalaksanaan VAP, khususnya pada kondisi di mana terapi konvensional menjadi kurang efektif. Evaluasi terhadap efektivitas klinis dan kelayakan ekonomi penggunaan CAZ-AVI menjadi penting untuk mendukung penggunaan antibiotik yang rasional serta membantu perencanaan kebijakan kesehatan.

Dalam beberapa tahun terakhir, sejumlah penelitian telah mengevaluasi luaran klinis dan nilai ekonomi penggunaan CAZ-AVI dalam penatalaksanaan pneumonia nosokomial serta infeksi yang disebabkan oleh organisme resisten karbapenem. Namun demikian, bukti yang tersedia berasal dari berbagai jenis penelitian yang heterogen, termasuk uji klinis teracak, studi observasional, serta analisis pemodelan ekonomi yang dilakukan dalam berbagai sistem pelayanan kesehatan. Oleh karena itu, diperlukan sintesis komprehensif dari bukti yang ada untuk memahami secara lebih baik manfaat klinis dan implikasi ekonomi dari terapi ini. Dengan demikian, tinjauan naratif ini bertujuan untuk merangkum dan mengevaluasi secara kritis bukti ilmiah terkait luaran klinis serta evaluasi ekonomi penggunaan CAZ-AVI dalam pengobatan HAP/VAP.

8. METODE

Desain Penelitian

Penelitian ini dilakukan dalam bentuk tinjauan naratif yang bertujuan untuk merangkum bukti ilmiah terkait luaran klinis dan evaluasi ekonomi penggunaan CAZ-AVI pada pengobatan HAP/VAP. Tinjauan ini disusun dengan mengacu pada *Scale for the Assessment of Narrative Review Articles* (SANRA) untuk memastikan kualitas metodologis yang baik. Penelusuran literatur dilakukan melalui empat basis data elektronik, yaitu PubMed, Scopus, ScienceDirect, dan Google Scholar. Artikel yang disertakan dalam tinjauan ini merupakan publikasi yang diterbitkan antara Januari 2015 hingga Juli 2025. Kata kunci yang digunakan dalam strategi pencarian meliputi "ceftazidime-avibactam", "ventilator-associated pneumonia", "hospital-acquired pneumonia", "clinical outcomes",

dan "cost-effectiveness." Artikel yang relevan diidentifikasi melalui proses penyaringan judul dan abstrak, kemudian dilanjutkan dengan evaluasi teks lengkap untuk menentukan kelayakan artikel.

Kriteria Eligibilitas

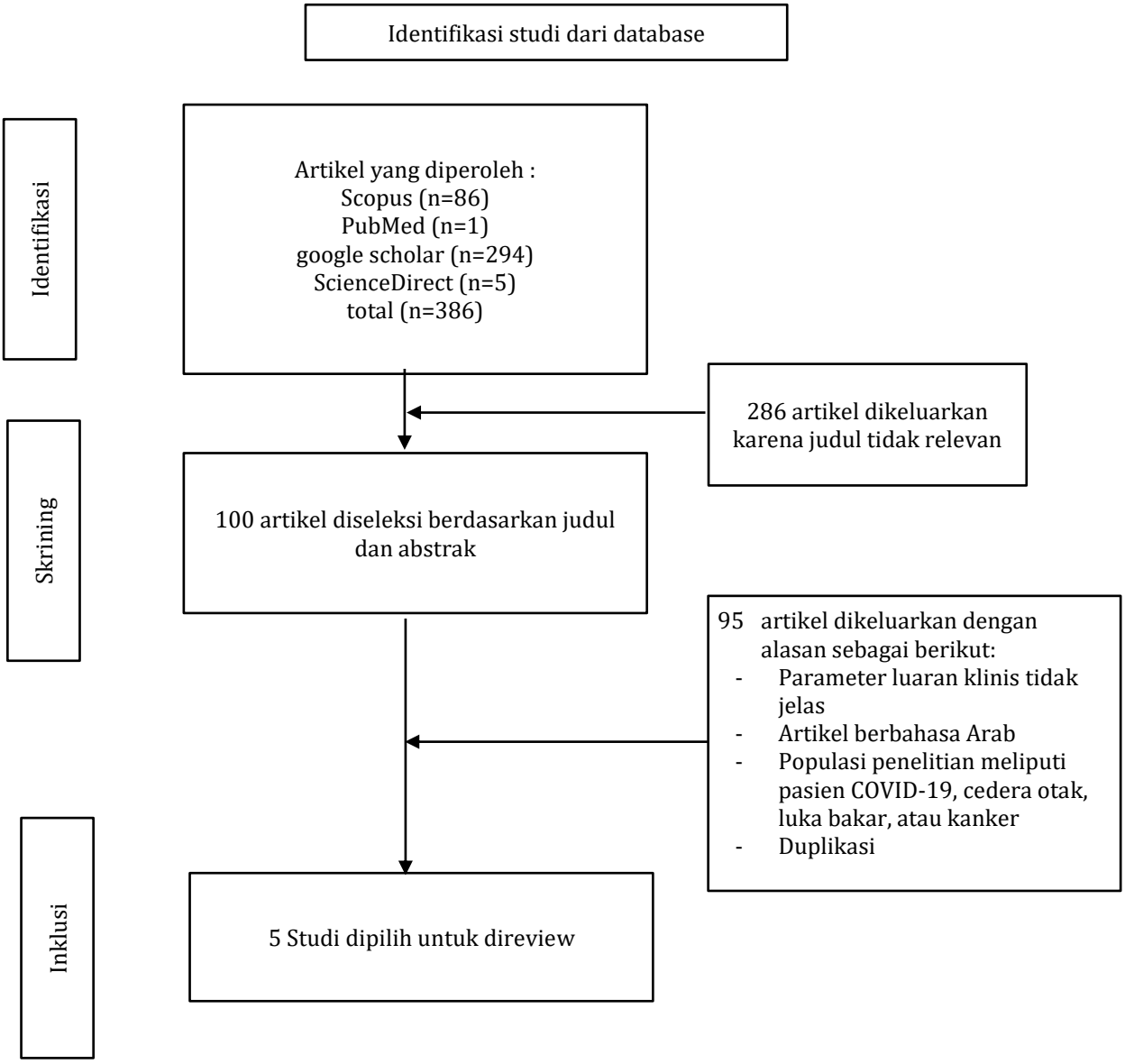
Kriteria inklusi dalam penelitian ini meliputi studi yang mengevaluasi penggunaan CAZ-AVI pada HAP/VAP, atau infeksi yang disebabkan oleh patogen resisten karbapenem; melaporkan luaran klinis (mortalitas, clinical cure, atau nefrotoksisitas) maupun luaran ekonomi (*incremental cost-effectiveness ratio*/ICER, *quality-adjusted life years*/QALY, atau biaya pelayanan kesehatan); tersedia dalam teks lengkap berbahasa Inggris; memiliki desain penelitian berupa uji klinis teracak, studi observasional, atau studi evaluasi ekonomi; serta dipublikasikan pada periode 2015–2025. Kriteria eksklusi meliputi laporan kasus atau komentar naratif, studi yang hanya membahas antibiotik pada model hewan atau penelitian in vitro, studi yang tidak melaporkan luaran klinis maupun ekonomi yang relevan, serta artikel yang tidak tersedia dalam bahasa Inggris.

Ekstraksi Data

Data dari studi yang memenuhi kriteria inklusi diekstraksi menggunakan formulir ekstraksi data yang telah distandarisasi. Informasi yang dikumpulkan meliputi desain penelitian, negara penelitian, karakteristik populasi studi, intervensi, komparator, luaran klinis yang dilaporkan, serta hasil evaluasi ekonomi. Temuan dari studi-studi yang diikutsertakan kemudian disintesis secara deskriptif.

9. HASIL

Bagan alur pada Gambar 1 menggambarkan proses penelusuran literatur dan seleksi studi yang dilakukan dalam tinjauan naratif ini. Proses dimulai dengan identifikasi 386 artikel yang diperoleh dari empat basis data utama, yaitu Scopus, PubMed, Google Scholar, dan ScienceDirect. Pada tahap penyaringan awal, sebanyak 286 artikel dikeluarkan karena judulnya tidak relevan dengan topik penelitian, sehingga tersisa 100 artikel. Artikel-artikel yang tersisa kemudian melalui proses penyaringan yang lebih lanjut berdasarkan judul dan abstrak untuk memastikan relevansinya dengan tujuan penelitian. Diagram tersebut juga menunjukkan bahwa 10 artikel diidentifikasi sebagai duplikat dan kemudian dikeluarkan dari analisis. Dengan demikian, sebanyak 90 artikel teks lengkap ditinjau untuk menentukan kelayakannya pada tahap berikutnya. Dari 90 artikel teks lengkap yang dievaluasi, sebanyak 83 artikel dikeluarkan karena berbagai alasan, antara lain tidak melaporkan luaran klinis yang jelas, adanya kendala bahasa (misalnya artikel berbahasa Arab), serta populasi penelitian yang tidak memenuhi kriteria inklusi. Pada akhirnya, lima studi memenuhi seluruh kriteria yang telah ditetapkan dan dimasukkan ke dalam analisis akhir.



Gambar 1. Diagram alur penelusuran literatur dan proses seleksi studi dalam tinjauan naratif

Tabel 1. Artikel yang diklasifikasikan berdasarkan desain penelitian, populasi, luaran klinis, dan temuan utama

No	Negara	Desain Studi	Populasi	Intervensi	Pembanding	Luaran Klinis	Temuan Utama	Referensi
1	Brazil	Pemodelan ekonomi (Markov model)	Pasien dewasa ICU yang disimulasikan dengan VAP akibat CRE/CRPa	CAZ-AVI	Polymyxin B	*28-day mortality*, neftrotoksisitas	CAZ-AVI dikaitkan dengan mortalitas dan nefrotoksisitas yang lebih rendah dibandingkan regimen berbasis polimiksin	[11]
2	Saudi Arabia	Studi kohort retrospektif	157 pasien dengan infeksi RE	CAZ-AVI	Terapi yang terseida	*14-day mortality* dan *30-day mortality*	CAZ-AVI dikaitkan dengan penurunan mortalitas 14 hari (HR = 0,46), namun tidak terdapat perbedaan signifikan pada mortalitas 30 hari.	[12]
3	Italia	Model ekonomi berbasis data uuji klinis teracak (RCT)	Pasien HAP/VAP yang disimulasikan	CAZ-AVI	Meropenem	*Clinical cure, life years*	Dibandingkan dengan meropenem yang diikuti kolistin dan meropenem dosis tinggi, ceftazidime-avibactam (CAZ-AVI) menunjukkan luaran klinis yang lebih baik, termasuk tingkat kesembuhan yang lebih tinggi (72,42% vs 58,90%), angka mortalitas di rumah sakit yang lebih rendah (16,32% vs 20,54%), serta peningkatan life-years dan QALYs. Namun, CAZ-AVI juga dikaitkan dengan tingkat kejadian efek samping yang sedikit lebih tinggi (8,66% vs 5,02%).	[13]
4	Colombia	Model ekonomi (decision tree)	Pasien dengan infeksi klebsiella CRE	CAZ-AVI	Colistin + Meropenem	*30-day mortality*	CAZ-AVI dikaitkan dengan penurunan mortalitas serta berkurangnya kebutuhan terapi antibiotik tambahan. Dalam kohort simulasi sebanyak 1.000 pasien, penggunaan CAZ-AVI diperkirakan dapat mencegah sekitar 228 kematian	[14]
5	Cina	Studi pemodelan ekonomi	Pasien HAP/VAP yang disimulasikan	CAZ-AVI	Meropenem	*Cure rate, mortality*	Regimen CAZ-AVI menunjukkan efektivitas klinis yang sedikit lebih baik dibandingkan regimen meropenem, dengan peningkatan tingkat kesembuhan sebesar 3,35% serta penurunan lama rawat inap sekitar 0,1 hari.	[15]

10. PEMBAHASAN

Efektivitas klinis ceftazidime-avibactam pada HAP/VAP

Ceftazidime-avibactam (CAZ-AVI) telah berkembang sebagai salah satu pilihan terapi yang penting dalam penatalaksanaan hospital-acquired pneumonia (HAP) dan ventilator-associated pneumonia (VAP), khususnya pada infeksi yang disebabkan oleh bakteri Gram-negatif multiresisten. Sejumlah penelitian, baik uji klinis teracak maupun studi observasional, telah mengevaluasi efektivitas klinis kombinasi antibiotik ini dalam pengobatan infeksi nosokomial yang berat. Uji klinis teracak REPROVE menunjukkan bahwa ceftazidime-avibactam tidak inferior dibandingkan meropenem dalam mencapai clinical cure serta luaran mortalitas pada pasien dengan HAP dan VAP. Hasil ini menunjukkan bahwa CAZ-AVI dapat menjadi alternatif terapi empiris pada pneumonia nosokomial yang disebabkan oleh bakteri Gram-negatif, terutama pada kondisi dengan peningkatan prevalensi resistensi terhadap karbapenem [13].

Selain uji klinis teracak, studi observasional juga melaporkan hasil yang mendukung penggunaan CAZ-AVI pada infeksi yang disebabkan oleh carbapenem-resistant Enterobacterales (CRE). Sebuah studi kohort retrospektif di Arab Saudi melaporkan bahwa terapi CAZ-AVI berhubungan dengan penurunan risiko mortalitas 14 hari dibandingkan dengan best available therapy (BAT), dengan nilai hazard ratio sebesar 0,45. Temuan ini menunjukkan bahwa CAZ-AVI berpotensi meningkatkan luaran klinis pada pasien dengan infeksi CRE, meskipun desain observasional penelitian tersebut membatasi kemampuan untuk menyimpulkan hubungan kausal secara langsung [12].

Secara keseluruhan, bukti klinis yang tersedia menunjukkan bahwa CAZ-AVI memiliki efektivitas klinis yang sebanding dengan terapi antibiotik konvensional dan berpotensi memberikan manfaat tambahan pada infeksi yang disebabkan oleh patogen resisten karbapenem. Namun demikian, penelitian prospektif dan studi dunia nyata masih diperlukan untuk memperkuat bukti mengenai efektivitas komparatif terapi ini dalam berbagai kondisi klinis.

Perbandingan dengan terapi berbasis kolistin

Secara historis, antibiotik golongan polimiksin, seperti kolistin dan polymyxin B, telah digunakan sebagai terapi lini terakhir untuk infeksi yang disebabkan oleh bakteri Gram-negatif resisten karbapenem. Namun demikian, penggunaan antibiotik ini sering dibatasi oleh risiko nefrotoksisitas yang tinggi serta efektivitas klinis yang terbatas pada beberapa kondisi. Beberapa studi klinis dan evaluasi ekonomi yang membandingkan CAZ-AVI dengan regimen berbasis polimiksin menunjukkan bahwa CAZ-AVI berpotensi memberikan luaran klinis dan profil keamanan yang lebih baik. Sebuah studi evaluasi ekonomi yang dilakukan di Brasil melaporkan bahwa penggunaan CAZ-AVI pada pasien dengan ventilator-associated pneumonia berhubungan dengan penurunan mortalitas dan kejadian nefrotoksisitas dibandingkan terapi polymyxin B. Perbaikan luaran klinis ini berkontribusi pada peningkatan quality-adjusted life years (QALY), sehingga mendukung potensi nilai klinis CAZ-AVI meskipun biaya obatnya relatif lebih tinggi [11].

Profil keamanan dan pertimbangan resistensi Ceftazidime-Avibactam (CAZ-AVI)

Ceftazidime-avibactam (CAZ-AVI) menunjukkan profil keamanan yang baik, terutama bila dibandingkan dengan agen konvensional seperti kolistin dan polimiksin, yang sering digunakan untuk mengobati infeksi yang disebabkan oleh organisme resisten karbapenem. Salah satu keunggulan utama CAZ-AVI adalah risiko nefrotoksisitas yang lebih rendah. Terapi berbasis kolistin, meskipun secara historis digunakan sebagai terapi standar untuk infeksi Gram-negatif multiresisten, telah diketahui memiliki risiko tinggi menyebabkan cedera ginjal akut. Hal ini memiliki implikasi klinis yang penting, terutama pada pasien kritis yang sudah memiliki risiko disfungsi organ[11].

CAZ-AVI juga memiliki efektivitas yang baik terhadap berbagai bakteri Gram-negatif resisten, termasuk strain Klebsiella pneumoniae yang memproduksi enzim karbapenemase OXA-48 dan KPC. Karakteristik ini menjadikan CAZ-AVI sebagai pilihan terapi yang penting dalam praktik klinis. Mekanisme resistensi tersebut semakin banyak ditemukan secara global dan menimbulkan tantangan besar dalam penatalaksanaan VAP dan infeksi nosokomial lainnya. Sebagai contoh, di Arab Saudi, Klebsiella pneumoniae penghasil OXA-48 telah diidentifikasi sebagai penyebab dominan infeksi CRE, sehingga menekankan pentingnya ketersediaan terapi yang mampu mengatasi enzim tersebut. Komponen avibactam dalam CAZ-AVI mampu menghambat β-laktamase kelas A, kelas C, dan beberapa kelas D, sehingga membantu mengatasi kebutuhan terapi yang penting tersebut[12].

Meskipun memiliki berbagai keunggulan, munculnya resistensi terhadap CAZ-AVI tetap menjadi perhatian yang perlu diwaspadai. Resistensi dapat berkembang selama terapi, terutama akibat mutasi pada protein porin atau peningkatan aktivitas efflux pump pada beberapa strain bakteri. Namun demikian, dibandingkan dengan karbapenem dan kolistin, CAZ-AVI tampaknya memiliki laju seleksi resistensi yang lebih lambat dan tetap efektif terhadap banyak strain bakteri yang telah resisten terhadap agen konvensional [15]. Oleh karena itu, penerapan program pengendalian penggunaan antibiotik (antimicrobial stewardship) serta pemantauan pola resistensi secara berkelanjutan sangat penting untuk mempertahankan efektivitas terapi ini dan mencegah perkembangan resistensi bakteri.

Secara keseluruhan, CAZ-AVI menawarkan kombinasi efektivitas dan keamanan yang baik, sehingga menjadi salah satu pilihan terapi yang menjanjikan dalam pengobatan infeksi nosokomial berat, termasuk hospital-acquired pneumonia dan ventilator-associated pneumonia, yang disebabkan oleh patogen Gram-negatif resisten. Tingkat toksisitas yang lebih rendah, khususnya terhadap fungsi ginjal, serta spektrum aktivitas yang luas terhadap mekanisme resistensi penting seperti OXA-48 dan KPC, semakin memperkuat peran CAZ-AVI dalam terapi antimikroba modern. Meskipun demikian, pemantauan pola resistensi dan penggunaan antibiotik secara rasional tetap menjadi faktor penting untuk mempertahankan efektivitas klinisnya serta mencegah munculnya resistensi di masa mendatang.

Economic evaluation and cost-effectiveness of Ceftazidime-Avibactam (CAZ-AVI)

Ceftazidime-avibactam (CAZ-AVI) telah banyak dievaluasi terkait efektivitas klinis dan nilai ekonominya dalam pengobatan hospital-acquired pneumonia (HAP), termasuk ventilator-associated pneumonia (VAP). Beberapa analisis cost-effectiveness telah menilai nilai ekonomi penggunaan ceftazidime–avibactam pada pasien dengan HAP dan VAP, khususnya pada kondisi dengan prevalensi patogen resisten karbapenem yang tinggi sebagaimana ditunjukkan pada Tabel 2. Uji klinis REPROVE, yang menunjukkan bahwa CAZ-AVI tidak inferior secara klinis dibandingkan meropenem, menjadi dasar bagi beberapa model ekonomi yang mengevaluasi implikasi biaya dari masing-masing strategi terapi [13]. Sebuah analisis cost-effectiveness terhadap terapi infeksi yang disebabkan oleh carbapenem-resistant Enterobacteriaceae (CRE) dilakukan di Italia. Analisis tersebut membandingkan urutan terapi konvensional berupa meropenem yang diikuti dengan kolistin dan meropenem dosis tinggi dengan urutan terapi menggunakan CAZ-AVI yang diikuti oleh kolistin dan meropenem dosis tinggi. Model tersebut menunjukkan bahwa CAZ-AVI meningkatkan clinical cure rate sebesar 13,52%, mengurangi lama rawat inap di rumah sakit sebesar 0,4 hari per pasien, serta menghasilkan peningkatan 0,195 life-years dan 0,350 quality-adjusted life years (QALYs). Nilai incremental cost-effectiveness ratio (ICER) yang dihasilkan adalah €3.581 per QALY, yang jauh lebih rendah dibandingkan ambang willingness-to-pay di Italia sebesar €30.000 per QALY. Temuan ini menunjukkan bahwa CAZ-AVI berpotensi menjadi strategi terapi yang cost-effective dalam sistem pelayanan kesehatan di Italia [13].

Sebuah model ekonomi berbasis decision tree yang dilakukan di China juga mengevaluasi cost-effectiveness CAZ-AVI dibandingkan dengan meropenem menggunakan data resistensi antimikroba dari praktik klinis nyata. Analisis dasar (base-case analysis) menunjukkan nilai ICER sebesar $35.328,2 per QALY, yang sedikit lebih rendah dibandingkan ambang willingness-to-pay di China sebesar $36.598 per QALY. Analisis sensitivitas menunjukkan bahwa tingkat prevalensi resistensi antibiotik memiliki pengaruh yang signifikan terhadap hasil cost-effectiveness, sehingga nilai ekonomi CAZ-AVI dapat lebih besar pada wilayah dengan tingkat resistensi karbapenem yang tinggi [15]. Evaluasi ekonomi di wilayah Amerika Latin juga menilai nilai penggunaan CAZ-AVI dalam pengobatan infeksi yang disebabkan oleh organisme resisten karbapenem. Di Kolombia, analisis cost-utility yang membandingkan CAZ-AVI dengan regimen kolistin–meropenem melaporkan adanya peningkatan sebesar 1,76 QALY per pasien dengan nilai ICER sebesar $3.317 per QALY. Meskipun nilai ICER ini sedikit melebihi ambang willingness-to-pay nasional sebesar $2.438, analisis tersebut menunjukkan bahwa CAZ-AVI berpotensi memberikan manfaat kesehatan tambahan dibandingkan terapi berbasis kolistin, khususnya pada infeksi yang disebabkan oleh patogen resisten [14]. Demikian pula, analisis cost-effectiveness yang dilakukan di Brasil membandingkan CAZ-AVI dengan polymyxin B dalam pengobatan ventilator-associated pneumonia yang disebabkan oleh patogen Gram-negatif resisten. Analisis tersebut menghasilkan nilai ICER sebesar BRL 35.298,65 per QALY. Hasil ini sebagian dipengaruhi oleh tingginya kejadian nefrotoksisitas serta luaran kelangsungan hidup yang lebih buruk pada terapi berbasis polimiksin, yang pada akhirnya memberikan profil ekonomi yang lebih menguntungkan bagi CAZ-AVI dalam model tersebut [11].

Secara keseluruhan, bukti ekonomi yang tersedia menunjukkan bahwa ceftazidime–avibactam berpotensi memberikan nilai ekonomi yang baik dalam pengelolaan pneumonia nosokomial yang disebabkan oleh patogen multiresisten. Namun demikian, sebagian besar temuan tersebut berasal dari studi pemodelan ekonomi dan dapat dipengaruhi oleh kondisi epidemiologi lokal, biaya pelayanan kesehatan, serta ambang willingness-to-pay di masing-masing negara. Oleh karena itu, nilai ekonomi CAZ-AVI perlu diinterpretasikan dalam konteks sistem pelayanan kesehatan yang spesifik.

Tinjauan ini memiliki beberapa keterbatasan yang perlu dipertimbangkan. Pertama, jumlah studi yang secara khusus mengevaluasi CAZ-AVI pada ventilator-associated pneumonia masih terbatas. Kedua, sebagian besar studi yang disertakan merupakan analisis pemodelan ekonomi atau studi observasional, bukan uji klinis teracak. Akibatnya, hasil penelitian dapat dipengaruhi oleh asumsi model atau faktor perancu yang tidak sepenuhnya dapat dikendalikan. Selain itu, studi-studi yang dianalisis dilakukan dalam sistem pelayanan kesehatan yang berbeda dengan pola resistensi antimikroba dan struktur biaya yang bervariasi, sehingga dapat membatasi generalisasi temuan ekonomi yang diperoleh. Penelitian selanjutnya diharapkan dapat berfokus pada studi prospektif berbasis praktik klinis nyata yang mengevaluasi baik luaran klinis maupun dampak ekonomi penggunaan CAZ-AVI dalam berbagai sistem pelayanan kesehatan.

Tabel 2. Artikel yang diklasifikasikan berdasarkan desain penelitian, populasi, luaran ekonomi, dan temuan utama

No	Country	Study Design	Population	Intervention	Comparator	Economic Outcomes	Key Findings	References
1	Brazil	Pemodelan ekonomi (Markov model)	Pasien ICU dewasa yang disimulasikan dengan VAP akibat CRE/CRPa	CAZ-AVI	Polymyxin B	QALY, ICER	CAZ-AVI menunjukkan profil keamanan yang lebih baik dan dinilai cost-effective dengan nilai ICER sebesar BRL 35.298/QALY. Pada analisis sensitivitas probabilistik (PSA), CAZ-AVI dinilai cost-effective pada 55% dan 89% simulasi dengan menggunakan ambang willingness-to-pay (WTP) masing-masing sebesar BRL 40.000 dan BRL 120.000 per QALY.	[11]
2	Italia	Pemodelan ekonomi	Pasien HAP/VAP yang disimulasikan	CAZ-AVI	Meropenem	QALY, ICER	CAZ-AVI menunjukkan hasil yang lebih baik dengan tambahan sebesar +0,35 QALY dan nilai ICER sebesar €3.581/QALY.	[13]
3	Colombia	Pemodelan ekonomi (decision tree)	Pasien dengan infeksi Klebsiella CRE yang disimulasikan	CAZ-AVI	Colistin + Meropenem	QALY, ICER	CAZ-AVI memberikan tambahan sebesar +1,76 QALY dengan nilai ICER sebesar $3.317/QALY.	[14]
5	Cina	Pemodelan ekonomi (decision tree)	Pasien HAP/VAP yang disimulasikan	CAZ-AVI	Meropenem	QALY, ICER	ICER $35.328/QALY; mendekati cost-effective berdasarkan ambang WTP di China.	[15]

11. KESIMPULAN

Bukti yang tersedia menunjukkan bahwa ceftazidime-avibactam berhubungan dengan luaran klinis yang baik dalam pengobatan hospital-acquired pneumonia (HAP) dan ventilator-associated pneumonia (VAP). terutama pada infeksi yang disebabkan oleh organisme resisten karbapenem. Evaluasi ekonomi yang dilakukan di beberapa negara juga menunjukkan bahwa ceftazidime-avibactam berpotensi menjadi pilihan terapi yang cost-effective dalam kondisi sistem pelayanan kesehatan tertentu serta berdasarkan ambang willingness-to-pay yang berlaku. Namun demikian, sebagian besar bukti yang tersedia saat ini masih berasal dari studi observasional dan analisis pemodelan ekonomi. Oleh karena itu, manfaat klinis dan ekonomi dari penggunaan ceftazidime-avibactam perlu diinterpretasikan secara hati-hati dan dapat berbeda pada setiap sistem pelayanan kesehatan. Penelitian prospektif lebih lanjut serta evaluasi berbasis praktik klinis nyata masih diperlukan untuk memperjelas efektivitas klinis dan nilai ekonomi terapi ini.

12. UCAPAN TERIMA KASIH

Penulis menyampaikan terima kasih yang sebesar-besarnya kepada Program Studi Magister Farmasi Klinik Universitas Gadjah Mada. Ucapan terima kasih juga disampaikan kepada para dosen pembimbing yang telah memberikan kontribusi yang sangat berharga. Bimbingan, masukan yang konstruktif, serta dukungan yang diberikan telah sangat membantu dalam proses penyusunan dan penulisan artikel ini.

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