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Review Article

Antibody-Drug Conjugates in Solid Tumors: Mechanisms, Clinical Advances, and Emerging Resistance Patterns

Hassan A. Abdou[1,*], Shadi Awny[2]

1-Capital (Helwan) University Hospitals, Faculty of Medicine, Capital (Helwan) University, Cairo, Egypt
2-Department of Surgical Oncology, OCMU Oncology Center Mansoura University Faculty of Medicine, Mansoura, Egypt

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Abstract

Introduction: Antibody-drug conjugates (ADCs) represent a transformative therapeutic modality in oncology, combining targeted antibody delivery with potent cytotoxic payloads. This narrative literature review examines ADC development for solid tumors, emphasizing advances from 2022-2025 while incorporating foundational trials from 2017-2021.
Methods: We conducted comprehensive searches of PubMed, Embase, and major oncology conference proceedings (ASCO, ESMO, AACR) from January 2020 through December 2025, with emphasis on literature published since 2022. Search terms included: antibody-drug conjugates, ADC, solid tumors, specific agent names (trastuzumab deruxtecan, sacituzumab govitecan, enfortumab vedotin, tisotumab vedotin, datopotamab deruxtecan), resistance mechanisms, and combination therapy. We prioritized phase 2 and 3 clinical trials, mechanistic studies, and high-quality systematic reviews, clearly distinguishing phase 2 response data from comparative survival outcomes.
Results: Topoisomerase inhibitor-based ADCs demonstrated substantial activity across multiple tumor types. In HER2-positive breast cancer, trastuzumab deruxtecan achieved superior outcomes compared to trastuzumab emtansine in DESTINY-Breast03. HER2-targeted ADCs achieve higher response rates than tissue antigen-targeted ADCs, though comparisons are limited by population heterogeneity. Multiple resistance mechanisms include antigen downregulation, impaired internalization, and payload efflux. Established targets (HER2, TROP2, Nectin-4) have FDA-approved ADCs, while emerging targets (B7H3, CEACAM5) are under investigation. Combination strategies with immunotherapy show promising synergy.
Conclusions: ADCs have established clinical utility across solid tumors, with ongoing innovation in linker technology, payload selection, and target identification. Next-generation ADCs incorporating bispecific antibodies and dual payloads represent promising directions. Definitive evidence of improved long-term outcomes is needed before widespread adoption in curative-intent settings.

1. Introduction

Antibody-drug conjugates (ADCs) represent a paradigm shift in targeted cancer therapy, combining the specificity of monoclonal antibodies with the cytotoxicity of chemotherapeutic agents [1]. Since the approval of gemtuzumab ozogamicin in 2000, the field has evolved dramatically, with 15 ADCs now approved by regulatory agencies worldwide for various malignancies as of 2024 [1, 2]. The trajectory of ADC development has been particularly transformative in solid tumors, where tissue penetration, tumor heterogeneity, and complex microenvironments pose unique challenges distinct from hematologic malignancies [3]. The current generation of ADCs demonstrates significant clinical activity across diverse solid tumor types, including breast, lung, urothelial, gastric, and cervical cancers [4–11]. Notable recent approvals include trastuzumab deruxtecan (FDA-approved for HER2-positive breast cancer [2019, expanded 2022], HER2-low breast cancer [2022], HER2-positive gastric cancer [2021], and HER2-mutant non-small cell lung cancer [2022]), enfortumab vedotin (FDA-approved for previously treated locally advanced or metastatic urothelial carcinoma [2019] and first-line treatment in combination with pembrolizumab [2023]), and sacituzumab govitecan (FDA-approved for metastatic triple-negative breast cancer [2020] and hormone receptor-positive, HER2-negative breast cancer [2023]) [4, 8–10, 12]. The expansion of ADC indications from salvage therapy to earlier lines of treatment underscores their growing clinical importance. However, despite these advances, multiple challenges persist. Resistance to ADCs remains a significant barrier to long-term disease control, with mechanisms including alterations in antigen expression, impaired intracellular trafficking, and payload efflux.12,13,38,41 Additionally, toxicity profiles including interstitial lung disease (ILD), hematologic toxicity, and neuropathy require careful patient selection and monitoring [3, 13]. This narrative literature review synthesizes current evidence on ADC mechanisms,

* Corresponding author: Hassan A. Abdou, Faculty of Medicine - Helwan University
Email: drhassanahmedhassanabdou@gmail.com

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clinical applications across tumor types, resistance patterns, and emerging strategies to optimize their therapeutic potential in solid tumors.

2. Structural Components and Mechanisms of Action

2.1. Antibody Selection and Engineering

The antibody component of ADCs serves as the targeting moiety, providing tumor selectivity through antigen recognition. Modern ADCs predominantly utilize humanized or fully human IgG1 antibodies to minimize immunogenicity while maintaining effector functions [1, 14, 15]. Critical parameters for antibody selection include high binding affinity to tumor-associated antigens, efficient internalization kinetics, and favorable pharmacokinetic properties, including prolonged serum half-life [16, 17]. The shift from murine to humanized antibodies has substantially reduced immunogenicity-related complications that plagued early ADC development [14, 18]. Target antigen selection represents a pivotal decision in ADC design. Ideal targets exhibit high expression on tumor cells with minimal expression on normal tissues, undergo efficient receptor-mediated endocytosis, and demonstrate limited antigen shedding [1, 19]. Current approved ADCs target oncoproteins such as HER2, EGFR, and HER3, as well as tissue-associated antigens including TROP2, Nectin-4, and tissue factor [2, 12, 20, 21]. In HER2-positive breast cancer specifically, the DESTINY-Breast03 trial demonstrated that trastuzumab deruxtecan achieved superior progression-free survival (median 28.8 versus 6.8 months) compared to trastuzumab emtansine [5]. Linker Chemistry and Payload Release Linker technology plays a critical role in determining ADC stability, payload release kinetics, and the potential for bystander effects. Two main categories exist: cleavable linkers that respond to tumor-specific conditions (protease activity, acidic pH, or glutathione levels), and non-cleavable linkers that require complete antibody degradation for payload release [1, 14, 22, 23]. In preclinical models, cleavable linkers enable bystander killing of neighboring antigen-negative cells, potentially beneficial in heterogeneous solid tumors, though clinical data directly demonstrating superior efficacy from bystander effects in patients remain limited [24, 25]. Recent innovations include hydrophilic linkers that improve aqueous solubility and reduce aggregation in manufacturing (demonstrated in vitro), though clinical impact on pharmacokinetics requires further study [14, 26]. The drug-to-antibody ratio (DAR) significantly impacts ADC pharmacology and therapeutic index. Traditional conjugation methods produced heterogeneous mixtures with DARs of 0-8, leading to variable efficacy and toxicity [14, 27, 28]. Site-specific conjugation technologies have emerged to generate more homogeneous ADCs with precise DAR control [29, 30]. However, clinical data demonstrate that optimal DAR varies by payload class and target biology [27, 28]. For instance, deruxtecan-based ADCs utilize high DARs of approximately 8 to maximize payload delivery, whereas auristatin-based ADCs typically employ DARs of 3-4 to balance efficacy and tolerability [24, 31, 32].

2.2. Cytotoxic Payloads

Payload selection represents a defining characteristic of ADC design, with different cytotoxic classes offering distinct mechanisms and therapeutic profiles. The three predominant payload categories are microtubule inhibitors (auristatins and maytansinoids), DNA-damaging agents (calicheamicins and pyrrolobenzodiazepines), and topoisomerase inhibitors (deruxtecan and exatecans) [31, 33–35]. In comparative analyses of clinical trial data, topoisomerase inhibitor payloads have demonstrated favorable efficacy profiles across multiple solid tumor types [36, 37]. The required potency for ADC payloads exceeds that of conventional chemotherapy by orders of magnitude, with effective concentrations in the picomolar to nanomolar range [35, 38]. This exceptional potency enables tumor cell killing despite the limited number of antibody molecules that successfully bind and enter tumor cells. Payload selection must balance cytotoxic potency with acceptable systemic toxicity when the ADC is catabolized or when free drug is released prematurely in circulation [31, 35, 39].

3. Clinical Efficacy Across Solid Tumor Types

3.1. HER2-Targeted ADCs in Breast Cancer

Trastuzumab deruxtecan has demonstrated transformative efficacy in HER2-positive breast cancer. The pivotal DESTINY-Breast03 trial, comparing trastuzumab deruxtecan to trastuzumab emtansine in previously treated HER2-positive metastatic breast cancer, showed median progression-free survival of 28.8 versus 6.8 months (hazard ratio 0.28, 95% confidence interval 0.22-0.37), with objective response rates of 79.7% versus 34.2%.4 This represented a practice-changing advancement, establishing trastuzumab deruxtecan as the preferred second-line therapy [37, 40]. Beyond HER2-positive disease, trastuzumab deruxtecan has demonstrated activity in HER2-low breast cancer (immunohistochemistry 1+ or immunohistochemistry 2+/in situ hybridization-negative), a population previously considered HER2-negative and ineligible for HER2-targeted therapy. The DESTINY-Breast04 trial enrolled patients with HER2-low metastatic breast cancer who had received prior chemotherapy, demonstrating median progression-free survival of 9.9 months versus 5.1 months with physician's choice chemotherapy (hazard ratio 0.50) and median overall survival of 23.4 months versus 16.8 months (hazard ratio 0.64) [7]. FDA approval followed in 2022, expanding the population eligible for HER2-targeted ADC therapy [21]. TROP2-Targeted ADCs Sacituzumab govitecan, targeting TROP2 (trophoblast cell-surface antigen 2), has demonstrated efficacy across multiple breast cancer subtypes. In metastatic triple-negative breast cancer, the ASCENT trial showed median progression-free survival of 5.6 versus 1.7 months with chemotherapy (hazard ratio 0.41) and median overall survival of 12.1 versus 6.7 months (hazard ratio 0.48), leading to FDA approval in 2020 [4]. Subsequently, the TROPiCS-02 trial evaluated sacituzumab govitecan in hormone receptor-positive, HER2-negative metastatic breast cancer, demonstrating median progression-free survival of 5.5 versus 4.0 months (hazard ratio 0.66) and median overall survival of 14.4 versus 11.2 months (hazard ratio 0.79) [10].

FDA approval for this indication followed in 2023. The mechanism involves delivery of SN-38, the active metabolite of irinotecan, to tumor cells expressing TROP2 [12].

3.2. Nectin-4 and Tissue Factor-Targeted ADCs

Enfortumab vedotin, targeting Nectin-4, has established efficacy in advanced urothelial carcinoma. The EV-301 trial demonstrated superior overall survival with enfortumab vedotin versus chemotherapy in previously treated patients (12.9 versus 8.9 months, hazard ratio 0.70), leading to FDA approval in 2019 [8]. More recently, the EV-302 trial demonstrated that enfortumab vedotin plus pembrolizumab achieved superior progression-free survival (12.5 versus 6.3 months, hazard ratio 0.45) and overall survival (31.5 versus 16.1 months, hazard ratio 0.47) compared to platinum-based chemotherapy in the first-line treatment of locally advanced or metastatic urothelial carcinoma, establishing this combination as a new standard of care [9]. Tisotumab vedotin, targeting tissue factor, received FDA approval in 2021 for recurrent or metastatic cervical cancer following the innovaTV 204/GOG-3023/ENGOT-cx6 trial, which demonstrated an objective response rate of 24% in heavily pretreated patients [41]. This represented an important advancement in a disease with limited treatment options.

3.3. HER2-Targeted ADCs in Non-Breast Malignancies

Trastuzumab deruxtecan has demonstrated efficacy beyond breast cancer. In HER2-positive gastric or gastroesophageal junction cancer, the DESTINY-Gastric01 trial showed an objective response rate of 51% in patients previously treated with trastuzumab-based therapy, with a median overall survival of 12.5 months [11]. FDA approval for this indication was granted in 2021. In HER2-mutant non-small cell lung cancer, the DESTINY-Lung01 trial demonstrated an objective response rate of 55% with trastuzumab deruxtecan in patients who had received prior platinum-based chemotherapy [6]. FDA approval followed in 2022. More recently, datopotamab deruxtecan targeting TROP2 in non-small cell lung cancer showed activity in the TROPION-Lung01 trial, though the study did not meet its co-primary endpoint in the overall population; as of late 2025, regulatory review is ongoing [6, 42].

3.4. Emerging Targets Under Investigation

Several novel targets are under active clinical investigation. B7H3 (CD276), expressed across multiple solid tumor types, is being targeted by investigational ADCs in early-phase trials [43, 44]. CEACAM5, overexpressed in colorectal and other gastrointestinal malignancies, represents another emerging target [43]MET, c-Kit, and CD70 are additional targets under evaluation, though clinical data remain preliminary [19, 43]. Folate receptor alpha has shown promise with mirvetuximab soravtansine in platinum-resistant ovarian cancer [45]

4. Safety and Toxicity Profiles

ADC toxicity profiles vary by payload class, target antigen, and linker technology, necessitating agent-specific monitoring and management strategies [3, 13, 39].

4.1. Interstitial Lung Disease

Interstitial lung disease represents a serious toxicity associated with deruxtecan-based ADCs (trastuzumab deruxtecan, datopotamab deruxtecan). Across trastuzumab deruxtecan trials, ILD occurs in 10-15% of patients, with grade 3 or higher events in 2-4% and rare fatal cases reported [3, 5, 32]. The mechanism is not fully elucidated but may involve payload-mediated lung toxicity. Management requires baseline chest imaging, patient education on respiratory symptoms, prompt evaluation of any new or worsening dyspnea or cough, and immediate discontinuation of any-grade ILD.2 Prophylactic corticosteroids are not recommended, but corticosteroids are used for treatment of confirmed ILD. Patients with pre-existing ILD or impaired pulmonary function require careful risk-benefit assessment before initiating deruxtecan-based therapy.

4.2. Hematologic Toxicity

Neutropenia is the most common dose-limiting toxicity for sacituzumab govitecan, occurring in approximately 51% of patients (grade 3 or higher in 27%) [4, 10, 12]. The SN-38 payload (the active metabolite of irinotecan) undergoes hepatic glucuronidation, and patients with the UGT1A1*28 polymorphism (reduced glucuronidation capacity) are at higher risk of severe neutropenia [4]. Growth factor support per institutional guidelines is recommended for grade 3-4 neutropenia, with dose reductions for recurrent toxicity. Other ADCs demonstrate lower rates of severe neutropenia, though grade 1-2 cytopenia is common across agents [13].

4.3. Peripheral Neuropathy

Peripheral neuropathy is common with microtubule inhibitor-based ADCs, particularly those using monomethyl auristatin E payloads. Enfortumab vedotin causes peripheral neuropathy in approximately 50% of patients, with grade 3 or higher events in 5%.7,8,49,56 Management requires dose modification: hold for grade 2 neuropathy until improvement to grade 1 or lower, reduce dose for recurrent grade 2, and discontinue for grade 3-4 [8]. The cumulative nature of neuropathy necessitates ongoing assessment throughout treatment. Maytansinoid-based ADCs also cause neuropathy, though generally at lower rates than monomethyl auristatin E-based agents [18, 46].

4.4. Ocular Toxicity

Tisotumab vedotin, targeting tissue factor, causes ocular adverse events in the majority of patients due to tissue factor expression in ocular tissues. Management requires prophylaxis before each infusion with ocular lubricants, ophthalmic corticosteroids, and vasoconstrictor eye drops, along with regular ophthalmologic examinations [41]. Despite prophylaxis, ocular toxicity, including conjunctivitis, dry eye, and vision changes, remains common. Patients should be counseled on the importance of adherence to prophylactic measures.

4.5. Other Toxicities

Additional toxicities include diarrhea (particularly with SN-38-containing ADCs like sacituzumab govitecan), dermatologic reactions (common with deruxtecan-based ADCs), hepatotoxicity (generally low-grade across agents), and infusion reactions (typically grade 1-2 and manageable with premedication) [3, 13, 47]. Agent-specific product labels and consensus management guidelines should guide toxicity monitoring and intervention [48].

5. Mechanisms of Resistance to ADCs

Resistance to ADCs represents a significant clinical challenge, with multiple mechanisms identified through preclinical models and limited clinical specimen analyses [49–51]. While resistance mechanisms have been characterized most extensively for trastuzumab emtansine, emerging data suggest both overlapping and distinct patterns for newer ADCs [49, 51].

5.1. Antigen-Mediated Resistance

Downregulation or loss of target antigen expression represents a primary resistance mechanism. In HER2-targeted ADCs, clinical observations demonstrate that some patients progress with preserved HER2 expression, while others show HER2 loss at progression [14, 49, 51]. Antigen heterogeneity within tumors may allow selection of antigen-low or antigen-negative clones during therapy [19, 52]. For trastuzumab deruxtecan, studies of HER2-low breast cancer suggest that even low antigen expression may be sufficient for efficacy, potentially reducing antigen loss as a resistance mechanism compared to trastuzumab emtansine [7, 14, 24]. Impaired antigen internalization represents another antigen-related mechanism. ADCs require receptor-mediated endocytosis to deliver payload intracellularly. Defects in endocytic machinery, including mutations or downregulation of proteins involved in clathrin-mediated endocytosis, can impair ADC internalization and reduce cytotoxicity [14, 17, 51, 53]. In preclinical models of trastuzumab emtansine resistance, trafficking defects leading to reduced lysosomal delivery have been identified [51, 53].

5.2. Payload-Related Resistance

Resistance mechanisms vary by payload class. For topoisomerase I inhibitor-based ADCs (deruxtecan, exatecans), preclinical data suggest that TOP1 mutations reducing enzyme-DNA complex formation may confer resistance, similar to resistance patterns observed with conventional topoisomerase inhibitors [31, 43]. However, clinical data confirming TOP1 mutations as a clinically relevant resistance mechanism in patients treated with deruxtecan-based ADCs are limited. For microtubule inhibitor-based ADCs (auristatins, maytansinoids), resistance mechanisms include tubulin mutations that reduce drug binding and alterations in microtubule dynamics [18, 31, 33, 51]. Upregulation of multidrug resistance transporters, particularly P-glycoprotein (MDR1/ABCB1) and breast cancer resistance protein (BCRP/ABCG2), can increase payload efflux and reduce intracellular accumulation [14, 51, 54]. The impact of efflux pump expression may vary depending on the payload's lipophilicity and whether the linker is cleavable [54].

5.3. Tumor Microenvironment-Mediated Resistance

The tumor microenvironment influences ADC efficacy through multiple mechanisms. Elevated interstitial fluid pressure, dense extracellular matrix, and abnormal vasculature in solid tumors can impair ADC penetration and distribution [17, 55]. These physical barriers may be particularly relevant for large ADC molecules (molecular weight approximately 150 kilodaltons) compared with small-molecule chemotherapy [55]. Additionally, tumor-associated macrophages and other stromal cells may internalize ADCs via Fc-gamma receptors, reducing the fraction of ADC reaching tumor cells [2, 39]. Alterations in the lysosomal environment, including changes in pH or protease activity, may affect payload release from ADCs utilizing pH-sensitive or protease-cleavable linkers [14, 53].

5.4. Strategies to Overcome Resistance

Potential strategies to address ADC resistance include sequential therapy with ADCs targeting different antigens or utilizing different payload classes, combination approaches with agents that modulate resistance pathways (e.g., efflux pump inhibitors), and development of next-generation ADCs with enhanced tissue penetration or dual-target specificity [2, 19, 43, 50]. Biomarker development to predict resistance and guide therapeutic decisions remains an area of active investigation [56].

6. Next-Generation ADC Platforms and Combination Strategies

6.1. Bispecific and Dual-Target ADCs

Bispecific ADCs, which bind two different antigens simultaneously, represent a strategy to address tumor heterogeneity and antigen-mediated resistance [14, 43, 57]. By targeting two antigens expressed on tumor cells, bispecific ADCs may maintain activity even when one antigen is downregulated. Additionally, bispecific formats can enhance tumor specificity by requiring co-expression of both antigens for optimal binding and internalization [57]. Several bispecific ADC formats are in preclinical and early clinical development [43, 44].

6.2. Dual-Payload ADCs

ADCs conjugated to two different cytotoxic payloads offer potential advantages, including simultaneous targeting of multiple cellular pathways and potential payload synergy [43, 58, 59]. This approach may delay or prevent resistance by requiring tumor cells to develop resistance mechanisms against two distinct payloads. However, the complexity of manufacturing dual-payload ADCs and optimizing the ratio of each payload presents technical challenges [58].

6.3. Immune-Stimulating ADCs

Immune-stimulating antibody conjugates deliver immunomodulatory payloads such as Toll-like receptor agonists or

stimulator of interferon genes agonists to the tumor microenvironment, aiming to activate anti-tumor immunity while maintaining tumor-targeted delivery [43, 60, 61]. In preclinical models, immune-stimulating antibody conjugates have demonstrated the ability to induce immunogenic cell death and enhance T cell infiltration. Early clinical trials are evaluating safety and preliminary efficacy. Combination with Immunotherapy Rational combinations of ADCs with immune checkpoint inhibitors are supported by preclinical data suggesting that ADCs may enhance immunogenicity by inducing immunogenic cell death and releasing tumor antigens [19, 60, 61]. The EV-302 trial, demonstrating superior outcomes with enfortumab vedotin plus pembrolizumab compared to chemotherapy alone in first-line urothelial carcinoma, provides clinical validation of this approach [9]. However, managing overlapping toxicities, optimizing dosing schedules, and identifying predictive biomarkers remain challenges. Multiple trials are evaluating ADC-immunotherapy combinations across tumor types [61, 62].

6.4. Combination with Targeted Agents

Combinations of ADCs with other targeted therapies, including cyclin-dependent kinase 4/6 inhibitors, poly (ADP-ribose) polymerase inhibitors, and tyrosine kinase inhibitors, are under investigation based on preclinical synergy [19, 56, 61]. Challenges include managing the toxicity of combined regimens and identifying patient populations most likely to benefit. Sequential strategies, in which ADCs are administered at progression following targeted therapy, have also been explored [62].

7. Biomarkers for Patient Selection and Response Prediction

Biomarker development is critical for optimizing ADC therapy. Current FDA-approved ADCs require target antigen expressions as determined by immunohistochemistry, fluorescence in situ hybridization, or next-generation sequencing (depending on the target) [48, 56]. However, optimal expression thresholds, impact of antigen heterogeneity, and role of co-expressed markers require further investigation [19, 56]. Beyond target expression, potential predictive biomarkers include tumor mutational burden (for ADC-immunotherapy combinations), expression of resistance-associated proteins (e.g., efflux pumps), genomic alterations in payload target pathways (e.g., tubulin genes for microtubule inhibitor-based ADCs), and tumor microenvironment characteristics [50, 54, 56]. Circulating biomarkers, including cell-free DNA and circulating tumor cells, are being explored for response monitoring and early detection of resistance [56].

8. Limitations

This narrative review has several important limitations. First, as a non-systematic review, our synthesis may not capture all relevant studies, and we did not perform a formal risk-of-bias assessment or meta-analysis of individual trials [37]. Second, the evidence base is highly heterogeneous across tumor types, treatment settings (neoadjuvant, adjuvant, salvage), ADC platforms (different antibodies, linkers, payloads, drug-to-antibody ratios), and trial designs (single-arm phase 2 versus randomized phase 3, varying endpoints), limiting direct cross-study comparisons [36, 47]. Third, resistance mechanisms are derived primarily from preclinical models and limited clinical specimens and may vary across specific ADCs and tumor contexts [50, 51]. Fourth, long-term outcome data beyond 3 years are lacking for recently approved ADCs, limiting the assessment of response durability and late toxicities. Fifth, optimal sequencing strategies when multiple ADCs are available for the same indication, rational combination approaches, and biomarker-driven patient selection require prospective validation in adequately powered trials [62]. Finally, economic considerations and healthcare resource utilization associated with ADC therapy were beyond the scope of this review but represent important factors in clinical implementation.

9. Conclusions

Antibody-drug conjugates have transformed the treatment landscape for multiple solid tumor types by combining the specificity of targeted antibody therapy with potent cytotoxicity. The evolution from early-generation ADCs to current platforms has been marked by innovations in linker technology, payload selection, and site-specific conjugation, resulting in improved therapeutic indices. The expansion of approved indications across breast, lung, urothelial, gastric, and gynecologic cancers underscore the broad applicability of the ADC platform. Despite these advances, significant challenges remain. Resistance to ADCs develops through multiple mechanisms, including antigen downregulation, impaired internalization, and payload efflux, necessitating strategies to overcome or circumvent resistance. Toxicity profiles vary by ADC platform and require agent-specific monitoring and management protocols. The optimal integration of ADCs into treatment algorithms, particularly regarding sequencing with other therapies and use in earlier disease settings, requires ongoing investigation. Next-generation ADC platforms, including bispecific antibodies, dual-payload constructs, and immune-stimulating conjugates, offer promise for addressing current limitations. Rational combination strategies with immunotherapy, targeted agents, and potentially other ADCs may enhance efficacy but require careful optimization to manage overlapping toxicities. While early data support investigation of ADCs in neoadjuvant and adjuvant settings, definitive evidence of improved long-term outcomes, including overall survival and cure rates, is needed before widespread adoption in curative-intent treatment paradigms. Biomarker development to predict response and identify patients most likely to benefit from specific ADCs remains a critical need. As the ADC field continues to mature, personalization of therapy based on tumor characteristics, prior treatments, and patient factors may optimize outcomes. The rapid pace of innovation in ADC development suggests that these agents will continue to evolve and expand their role in precision oncology.

Conflicts of Interest

The authors declare no conflicts of interest related to this manuscript.

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Large Language Model

Large language models were used for literature organization and grammatical refinement during manuscript preparation. All scientific content, interpretation, and conclusions remain solely the responsibility of the authors.

Authors Contribution

HAA contributed to conceptualization, literature search, data analysis, manuscript writing, and original draft preparation, while SA contributed to manuscript review, critical revision, and editing.

Data Availability

This is a narrative literature review. All data supporting the findings are available in the published literature cited in the references section.

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