Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6, 3457-3464
2024
Publisher: Learning Gate
DOI: 10.55214/25768484.v8i6.2731

Phenytoin-induced DRESS syndrome: A multidisciplinary case study in precision medicine and advanced therapeutics

Frida Kurnia Pratama[1,2], Zahrah Hikmah[1,2*], Evy Ervianti[3,4], Prastiya Indra Gunawan[1,2], Felix Hartanto[3,4], Azwin Mengindra Putra[1,2], Anang Endaryanto[1,2]
[1]Department of Child Health, Dr Soetomo General Academic Hospital, Surabaya.
[2]Department of Child Health, Faculty of Medicine - Universitas Airlangga, Surabaya; dr.zahrah.hikmah@fk.unair.ac.id (Z.H.)
[3]Department of Dermatology Venereology and Esthetic, Dr Soetomo General Academic Hospital, Surabaya.
[4]Department of Dermatology Venereology and Esthetic, Faculty of Medicine - Universitas Airlangga, Surabaya.

Abstract: This case report aims to examine the diagnostic and therapeutic approach for phenytoin-induced Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS) syndrome in a pediatric patient, emphasizing the importance of early recognition and intervention. A 17-year-old male presented with a pruritic rash, fever, lymphadenopathy, and elevated liver enzymes one month after starting phenytoin for epilepsy. Diagnosis was confirmed using the RegiSCAR scoring system, which objectively assessed clinical and laboratory findings. The patient received high-dose corticosteroids and N-acetylcysteine (NAC) after discontinuing phenytoin, with regular monitoring of clinical and laboratory parameters. Timely withdrawal of phenytoin, along with corticosteroid and NAC therapy, led to the resolution of symptoms without long-term complications. The RegiSCAR scoring system proved invaluable for accurate and swift diagnosis, supporting its utility in pediatric DRESS cases. This case also suggests the potential of genetic screening, particularly HLA typing, for identifying high-risk individuals, although it was not utilized here. Early diagnosis and multidisciplinary management are critical for favorable outcomes in pediatric DRESS cases. Routine HLA screening could help prevent DRESS syndrome in patients prescribed high-risk medications, though further studies are needed to assess feasibility and cost-effectiveness. This case underlines the value of standardized treatment protocols and personalized medicine in managing drug hypersensitivity reactions effectively.

Keywords: *Corticosteroid therapy, Hypersensitivity reaction, DRESS syndrome, Phenytoin, Pediatric epilepsy.*

1. Introduction

Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS) syndrome, also known as Drug-Induced Hypersensitivity Syndrome (DIHS), is a rare but potentially life-threatening condition triggered by various medications, including anticonvulsants like phenytoin. DRESS is classified as a severe cutaneous adverse reaction (SCAR) and can result in multiorgan involvement, including the liver, kidneys, and lungs, leading to significant morbidity and mortality [1,2]. The incidence of DRESS is estimated to occur in 1 out of 1,000 to 1 out of 10,000 patients treated with anticonvulsants, but the condition remains under-recognized, particularly in pediatric populations [3].

This case report presents a 17-year-old male with phenytoin-induced DRESS syndrome, emphasizing the unique challenges of diagnosing and managing this condition in adolescents. While DRESS is more frequently documented in adults, its occurrence in younger patients is rare, and the diagnostic process can be complicated by the overlap with other severe cutaneous adverse reactions, such as Stevens-Johnson Syndrome (SJS) and Toxic Epidermal Necrolysis (TEN) [4]. Pediatric DRESS poses a significant challenge to clinicians, as delayed recognition and intervention can lead to severe systemic involvement, affecting multiple organs such as the liver, kidneys, and lungs, thereby increasing morbidity [2].

This case contributes to the limited body of literature on pediatric DRESS syndrome and

* Correspondence: dr.zahrah.hikmah@fk.unair.ac.id

emphasizes the potential role of precision medicine, particularly through genetic screening such as HLA typing, in preventing adverse drug reactions. Research indicates that certain HLA alleles, such as HLA-B*51:01 and HLA-C*14:02, are associated with an increased risk of phenytoin-induced DRESS [2,5]. The application of the RegiSCAR scoring system in this case facilitated a timely and accurate diagnosis, guiding the multidisciplinary management approach that ultimately led to a full recovery without long-term complications [1].

The treatment strategy for this patient involved a multidisciplinary approach, including high-dose corticosteroids and N-acetylcysteine (NAC), which facilitated the patient's full recovery without long-term complications. Multidisciplinary care is often necessary in managing DRESS, as systemic involvement may require input from various specialties [4]. This case underscores the importance of early detection and tailored treatment, especially when managing DRESS in the pediatric population.

By presenting this case, we aim to raise awareness of pediatric DRESS syndrome, advocate for the integration of genetic screening in routine practice, and contribute to the growing body of research focused on improving diagnostic accuracy and therapeutic outcomes in this vulnerable population [3,6].

2. Case Presentation

A 17-year-old male with a history of epilepsy, diagnosed at the age of 15, presented with a generalized pruritic maculopapular rash that progressively spread from his hands to the rest of his body over two days. He also reported a persistent fever reaching up to 40°C, which had begun approximately one month earlier. Despite the use of paracetamol, his fever did not resolve. Additionally, the patient experienced leg soreness, but there was no significant family history of drug allergies or similar conditions.

The patient had been prescribed phenytoin to manage his epilepsy and had been taking it orally three times daily for one month prior to presentation. On examination, he was hemodynamically stable, but notable findings included generalized maculopapular lesions, particularly on the trunk and extremities (Figure 1), and lymphadenopathy in the cervical, axillary, and inguinal regions. The largest lymph node, located in the right axilla, measured approximately 2 cm in diameter. No mucosal involvement or facial edema was observed.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3457-3464, 2024
DOI: 10.55214/25768484.v8i6.2731

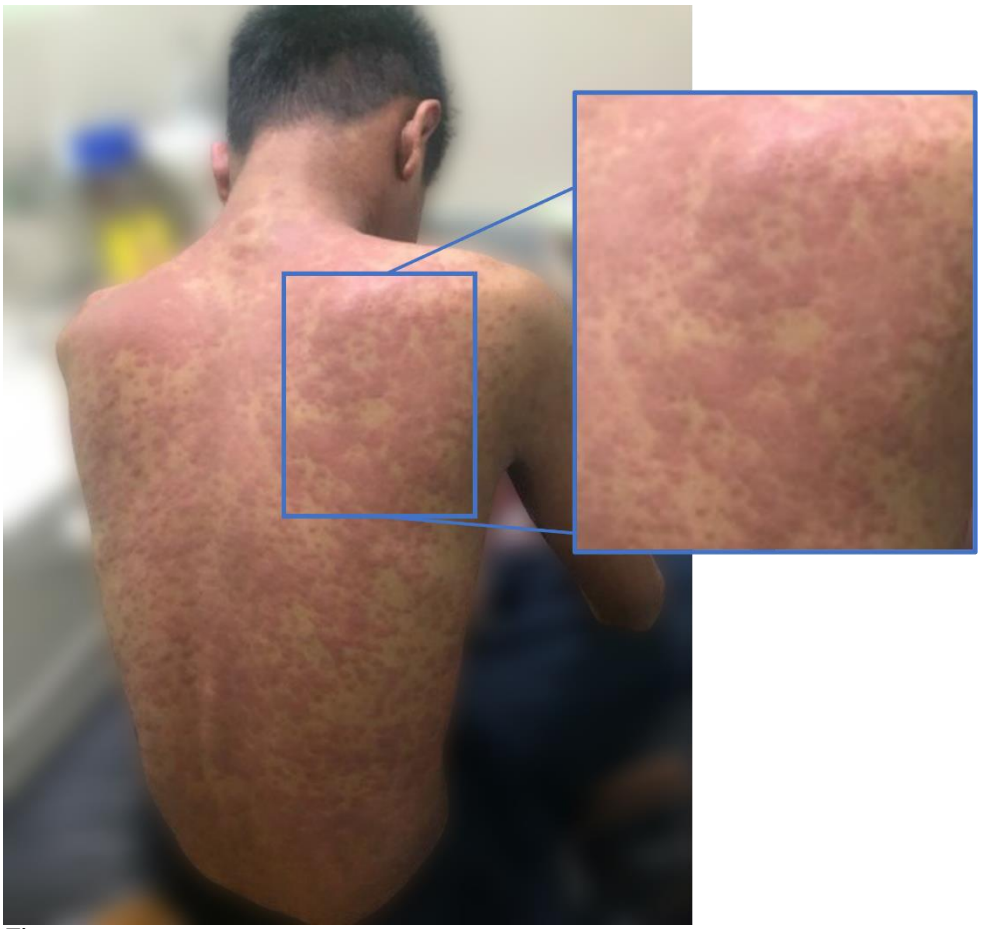

Figure 1.
Generalized maculopapular rash in a 17-year-old male with phenytoin-induced DRESS syndrome.

Laboratory investigations revealed marked eosinophilia (8.8%) and elevated liver enzymes (AST 208 U/L, ALT 329 U/L). C-reactive protein levels were elevated, but autoimmune markers, including ANA and dsDNA, were negative Table 1. Blood culture grew *Staphylococcus saprophyticus*, though this was considered a contaminant. Based on these findings and a RegiSCAR score of 6 Table 2, a diagnosis of phenytoin-induced DRESS syndrome was made. Phenytoin was discontinued, and high-dose intravenous methylprednisolone, oral cetirizine, and supportive care were initiated.

Table 1.
Summary of key laboratory findings.

Parameter	Result	Reference range
Eosinophils	8.8%	0-6%
AST	208 U/L	10-40 U/L
ALT	329 U/L	7-56 U/L
C-reactive protein	5,37 mg/L	<3 mg/L
ANA, dsDNA	Negative	Negative

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3457-3464, 2024
DOI: 10.55214/25768484.v8i6.2731

Table 2.
RegiSCAR scoring for diagnosis of DRESS syndrome in a 17-year-old male.

Items	Score			Comments
	−1	0	1	
Fever ≧ 38.5 °C	N/U	Y		
Enlarged lymph nodes		N/U	Y	>1 cm and ≧ 2 different areas
Eosinophilia ≧ 0.7 × 10⁹/L or ≧ 10% if WBC < 4.0 × 10⁹/L		N/U	Y	Score 2, when ≧ 1.5 × 10⁹/L or ≧ 20% if WBC < 4.0 × 10⁹/L
Atypical lymphocytosis		N/U	Y	
Skin rash				Rash suggesting DRESS: ≧ 2 symptoms: purpuric lesions (other than legs), infiltration, facial edema, psoriasiform desquamation
Extent > 50% of BSA		N/U	Y	
Rash suggesting DRESS	N	U	Y	
Skin biopsy suggesting DRESS	N	Y/U		
Organ involvement		N	Y	Score 1 for each organ involvement, maximal score: 2
Rash resolution ≧ 15 days	N/U	Y		
Excluding other causes		N/U	Y	Score 1 if 3 tests of the following tests were performed and all were negative: HAV, HBV, HCV, Mycoplasma, Chlamydia, ANA, blood culture

ANA: anti-nuclear antibody; BSA: body surface area; HAV: hepatitis A virus; HBV: hepatitis B virus; HCV: hepatitis C virus; N: no; U: unknown; WBC: white blood cell; Y: yes.

3. Discussion

DRESS syndrome presents significant diagnostic challenges due to its variable manifestations and overlapping features with other severe cutaneous adverse reactions (SCARs) such as Stevens-Johnson Syndrome (SJS) and Toxic Epidermal Necrolysis (TEN). The RegiSCAR scoring system has proven to be a highly effective, technology-driven tool for confirming the diagnosis of DRESS syndrome. This scoring system evaluates several key clinical parameters, including fever, eosinophilia, skin rash, and organ involvement, allowing for a systematic and objective approach to diagnosis [7]. Prompt recognition of DRESS and discontinuation of phenytoin were critical in preventing further systemic damage, underscoring the importance of early diagnosis in improving patient outcomes. This aligns with previous literature that emphasizes the necessity of early drug withdrawal and the use of corticosteroids as first-line therapy in cases with significant systemic involvement [8].

The RegiSCAR scoring system is particularly valuable because it provides a reproducible method for assessing the severity of DRESS. The incorporation of this technology into clinical workflows facilitates earlier intervention and improves clinical outcomes [9]. With advancements in health informatics, this diagnostic tool could potentially be enhanced by incorporating artificial intelligence (AI) algorithms that analyze patient data more rapidly, offering even greater precision in identifying patients at risk of DRESS [10]. The combination of RegiSCAR with AI-driven diagnostic platforms may represent a future direction for improving both the accuracy and speed of DRESS diagnosis.

In terms of treatment, the role of N-acetylcysteine (NAC) in managing drug-induced liver injury, as seen in DRESS syndrome, highlights its potential as a therapeutic agent. NAC acts as an antioxidant, reducing oxidative stress and supporting the regeneration of liver cells [11]. As biotechnological advances continue, there is an opportunity to optimize NAC formulations to enhance its bioavailability and therapeutic efficacy. Novel drug delivery systems, such as nanoparticle formulations, could be explored to improve the pharmacokinetics of NAC, ensuring that it reaches target tissues more effectively [12]. This would be particularly beneficial in managing severe systemic reactions like DRESS, where liver involvement is common [13].

Technological innovation in healthcare is rapidly transforming the management of complex conditions like DRESS syndrome. One area of significant advancement is pharmacogenomics, which

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3457-3464, 2024
DOI: 10.55214/25768484.v8i6.2731

focuses on understanding how an individual's genetic makeup influences their response to medications. In the context of DRESS syndrome, genetic variants in HLA alleles, particularly HLA-B15:13 and HLA-A31:01, have been strongly associated with an increased risk of developing severe hypersensitivity reactions to drugs like phenytoin [6]. HLA typing could play a crucial role in preventing DRESS by identifying at-risk individuals before initiating therapy with high-risk drugs [14].

Additionally, this case brings attention to the potential role of genetic screening in preventing DRESS syndrome. Although HLA typing was not performed in this patient, the literature suggests that genetic predispositions, such as specific HLA polymorphisms (HLA-B15:13, HLA-A31:01), are associated with an increased risk of developing DRESS, particularly in certain populations. Routine genetic screening, however, remains limited in clinical practice due to the cost and availability of such tests. Further studies are needed to explore the cost-effectiveness of incorporating HLA typing into routine clinical care, particularly for high-risk populations such as Southeast Asians, where certain HLA alleles are more prevalent.

In clinical practice, the incorporation of genetic screening technologies has the potential to revolutionize the approach to prescribing anticonvulsants and other medications that carry a high risk of inducing hypersensitivity reactions. By personalizing treatment based on an individual's genetic profile, healthcare providers can significantly reduce the incidence of severe adverse drug reactions [6]. As precision medicine continues to evolve, genetic screening will likely become an integral part of routine clinical care, particularly for patients with epilepsy or other conditions requiring long-term pharmacotherapy. This approach aligns with the principles of individualized treatment and is expected to improve patient safety by minimizing the risks associated with drug hypersensitivity [15].

Recent innovations in genetic testing, such as Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR-based diagnostics) and high-throughput sequencing, offer exciting prospects for more efficient and accessible HLA screening [16]. These advancements could streamline the process of identifying genetic predispositions to DRESS and other SCARs, allowing clinicians to make more informed decisions when prescribing medications [17]. The future of DRESS management may involve a more integrated approach, where genetic data is used in conjunction with clinical assessment tools like the RegiSCAR scoring system to create a comprehensive risk profile for each patient [6].

The management of DRESS syndrome requires a multidisciplinary approach due to its multisystem involvement. Collaboration between dermatologists, hepatologists, immunologists, and pharmacologists is essential to ensure comprehensive care [18]. This case illustrates the importance of integrating expertise from various medical disciplines to address the complex pathophysiology of DRESS.

From a pharmacological perspective, biotechnological advances offer new avenues for reducing the risk of hypersensitivity reactions. Chemical modification of drugs like phenytoin could potentially decrease the formation of toxic metabolites responsible for immune activation and tissue damage [19]. Moreover, the development of safer anticonvulsant therapies remains a key area of focus in pharmacological research. As new drugs are developed, there is a growing emphasis on minimizing adverse effects while maximizing therapeutic benefits. The trend toward safer, more targeted therapies reflects a broader movement in pharmacology, particularly in the treatment of epilepsy, where alternatives such as levetiracetam are increasingly favored due to their lower risk of inducing hypersensitivity reactions compared to traditional drugs like phenytoin [20].

In this case, the use of N-acetylcysteine (NAC) demonstrates how a multidisciplinary approach, combining pharmacology and hepatology, can improve patient outcomes. The adjunctive use of NAC in managing liver dysfunction associated with DRESS highlights the importance of understanding drug metabolism and the potential for targeted interventions [21]. Moving forward, the collaboration between pharmacologists and biotechnologists may yield innovative therapies that can mitigate the systemic effects of drug-induced hypersensitivity, offering new treatment paradigms for conditions like DRESS [22].

Technological advancements in clinical monitoring play a critical role in managing patients with DRESS syndrome. Given the systemic nature of DRESS, involving organs such as the liver, kidneys,

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3457-3464, 2024
DOI: 10.55214/25768484.v8i6.2731

and lungs, continuous monitoring of organ function is essential. Modern diagnostic tools such as functional MRI and digital biomarkers enable real-time assessment of organ health, allowing clinicians to detect early signs of organ dysfunction before irreversible damage occurs [23]. However, in this particular case, the diagnosis was effectively established without the need for advanced technologies like MRI. The application of the RegiSCAR scoring system, along with clinical evaluations and laboratory tests, provided sufficient information for accurate diagnosis and timely intervention [7]. These technologies are instrumental in managing complex cases like DRESS, where timely intervention can prevent long-term complications [24].

Additionally, AI-based clinical decision support systems have the potential to revolutionize the management of DRESS. By analyzing large datasets of clinical variables, these systems can assist clinicians in predicting the trajectory of DRESS and optimizing treatment strategies. For example, AI algorithms could analyze patterns of liver enzyme fluctuations, eosinophil counts, and skin rash progression to guide corticosteroid dosing and duration [25]. These tools could lead to more precise, data-driven management of DRESS, reducing morbidity and improving patient outcomes [26].

The integration of AI with biomonitoring technology also offers new possibilities for long-term follow-up of patients recovering from DRESS. Since DRESS can cause chronic sequelae, including long-term liver and kidney dysfunction, continuous monitoring using wearable devices that track vital signs and biochemical markers could enable earlier detection of relapse or late-onset complications [27]. These technologies not only improve the immediate management of DRESS but also contribute to reducing long-term morbidity by facilitating proactive intervention.

This case underscores the practical applications of current technologies and treatment strategies in the management of DRESS syndrome. The successful use of the RegiSCAR scoring system demonstrates its effectiveness as a diagnostic tool in applied clinical settings, ensuring timely identification of DRESS and allowing for the initiation of appropriate treatment [7]. Similarly, the use of N-acetylcysteine (NAC) as an adjunctive therapy for liver injury exemplifies the integration of pharmacology and biomedicine in real-world clinical practice [13].

As technology continues to advance, the application of these innovations in managing complex hypersensitivity reactions like DRESS is expected to expand. Future research should focus on optimizing diagnostic algorithms, enhancing the bioavailability of therapeutic agents like NAC, and exploring the potential for genetic screening to prevent adverse drug reactions [10]. By building on these applied science concepts, clinicians can improve patient outcomes and contribute to the growing field of precision medicine [28].

The management of DRESS syndrome aligns with several key trends in contemporary medical science, including the rise of precision medicine and pharmacogenomics. As the field of individualized therapy grows, more emphasis is being placed on tailoring treatments to each patient's unique genetic makeup. This case highlights how genetic factors such as HLA alleles play a critical role in determining a patient's susceptibility to drug reactions, reinforcing the importance of genetic screening as a preventive measure [10].

In addition, advancements in anticonvulsant therapy continue to evolve, with an increasing focus on developing drugs that are less likely to induce SCARs. The trend toward safer, more targeted therapies reflects a broader movement in pharmacology to minimize adverse effects while maximizing therapeutic benefits. As new drugs and technologies are developed, the management of conditions like DRESS will continue to improve, offering hope for better patient outcomes and reduced treatment-associated risks [8].

4. Conclusion

This case underscores the critical importance of early diagnosis and prompt intervention in managing DRESS syndrome in pediatric patients. The discontinuation of phenytoin, combined with corticosteroid therapy and N-acetylcysteine (NAC), facilitated a full recovery without long-term complications. Despite the positive outcome, this case highlights the need for standardized treatment protocols for pediatric DRESS, given the limited reporting and unique challenges in this population.

Moving forward, the integration of genetic screening, such as HLA typing, to identify high-risk

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3457-3464, 2024
DOI: 10.55214/25768484.v8i6.2731

individuals represents a promising preventive approach. Implementing routine genetic screening in clinical practice could help personalize treatment and minimize adverse reactions. Future research should focus on refining management strategies for pediatric DRESS, including optimal corticosteroid dosing and supportive therapies, and exploring the feasibility and cost-effectiveness of routine genetic testing in populations prescribed high-risk medications like anticonvulsants. Establishing standardized protocols and expanding genetic screening could significantly improve patient safety and clinical outcomes.

Copyright:

References

[1] S. John, K. Balakrishnan, C. Sukasem, T. C. Vijay Anand, B. Canyuk, and S. Pattharachayakul, "Association of HLA-B51:01, HLA-B55:01, CYP2C93, and Phenytoin-Induced Cutaneous Adverse Drug Reactions in the South Indian Tamil Population," J Pers Med, vol. 11, pp. 737, 2021. DOI:10.3390/jpm11080737

[2] W. Manuyakorn, P. Likkasittipan, S. Wattanapokayakit, S. Suvichapanich, W. Inunchot, N. Wichukchinda, et al., "Association of HLA genotypes with phenytoin induced severe cutaneous adverse drug reactions in Thai children," Epilepsy Res, vol. 162, pp. 106321, 2020. DOI: 10.1016/j.eplepsyres.2020.106321

[3] K. Hikino, T. Ozeki, M. Koido, C. Terao, Y. Kamatani, Y. Mizukawa, et al., "HLA-B*51:01 and CYP2C93* are risk factors for phenytoin-induced eruption in the Japanese population: analysis of data from the Biobank Japan Project," Clin Pharmacol Ther, vol. 107, no. 5, pp. 1170-1178, 2020. DOI:10.1002/cpt.1706

[4] E. Y. Kim, M. Y. Kim, C. S. Park, J.-H. Choi, J. Ghim, H. S. Kim, et al., "Antiepileptic drug-induced severe cutaneous adverse reactions and HLA alleles: A report of five cases with lymphocyte activation test," Transl Clin Pharmacol, vol. 27, no. 2, pp. 64–68, 2019. DOI:10.12793/tcp.2019.27.2.64

[5] A. A. Somogyi, D. T. Barratt, E. J. Phillips, K. Moore, F. Ilyas, and G. M. Gabb, "High and variable population prevalence of HLA-B*56:02 in indigenous Australians and relation to phenytoin-associated drug reaction with eosinophilia and systemic symptoms," Br J Clin Pharmacol, vol. 85, no. 9, pp. 2163-2169, 2019. DOI:10.1111/bcp.14025

[6] B. Kloypan, N. Koomdee, P. Satapornpong, T. Tempark, M. Biswas, and C. Sukasem, "A comprehensive review of HLA and severe cutaneous adverse drug reactions: Implication for clinical pharmacogenomics and precision medicine," Pharmaceuticals, vol. 14, no. 11, pp. 1077, 2021. DOI:10.3390/ph14111077

[7] S. Sasidharanpillai, K. Ajithkumar, P. Jishna, A. Khader, K. Anagha, M. Binitha, et al., "RegiSCAR DRESS (Drug Reaction with Eosinophilia and Systemic Symptoms) Validation Scoring System and Japanese Consensus Group Criteria for Atypical Drug-Induced Hypersensitivity Syndrome (DiHS): A Comparative Analysis," Indian Dermatol Online J, vol. 13, no. 1, pp. 40–45, 2022. DOI: 10.4103/idoj.idoj_196_21

[8] V. M. Lumbantoruan and E. Harianja, "Probable Dress Syndrome: A Case of Drug Hypersensitivity in a Young Man," Proc 2nd Int Conf Trop Med Infect Dis, vol. 2, pp. 441-444, 2019. DOI:10.5220/0009991104410444

[9] S. Momen, S. Diaz-Cano, S. Walsh, and D. Creamer, "Discriminating 'DRESS minor' from 'DRESS major': facial oedema aligns to the severe phenotype," J Am Acad Dermatol, vol. 84, no. 4, pp. e1-e8, 2021. DOI: 10.1016/j.jaad.2021.04.020

[10] M. Danjuma, L. Naseralallah, B. Aboujabal, M. Mohamed, I. Abubeker, L. A. Abdul Jabbar, et al., "An investigation into the avoidability of drug reaction with eosinophilia and systemic symptoms (DRESS) syndrome," Sci Rep, vol. 11, pp. 1-8, 2021. DOI:10.1038/s41598-021-97381-6

[11] A. Toniato, C. Gamba, J. Schroeder, V. Fabbri, S. V. Bernal Ortiz, L. Borgonovo, et al., "Role of Multiple Comorbidities and Therapies in Conditioning the Clinical Severity of DRESS: A Mono-Center Retrospective Study of 25 Cases," Int J Mol Sci, vol. 22, pp. 7072, 2021. DOI:10.3390/ijms22137072

[12] C. Capella-Peris, M. M. Cosgrove, I. Chrismer, M. Emile-Backer, M. Razaqyar, J. S. Elliott, et al., "Mixed methods analysis of Health-Related Quality of Life in ambulant individuals affected with RYR1-related myopathies pre-post-N-acetylcysteine therapy," Qual Life Res, vol. 29, pp. 1641-1653, 2020. DOI:10.1007/s11136-020-02428-2

[13] B. Panda, V. Suryawanshi, A. Raut, S. Joshi, and B. Purandare, "Antitubercular therapy causing drug reaction with eosinophilia and systemic symptoms manifesting multi-organ dysfunction syndrome and death in an elderly patient: A case report with review of literature," Int J Mycobacteriol, vol. 12, pp. 360-363, 2023. DOI: 10.4103/ijmy.ijmy_8_23

[14] L. Speicher, S. Crosby, and M. Schuh, "Pharmacogenomics testing confirmation of carbamazepine induced DRESS reaction of an HLA-A*31:01 positive, polypharmacy patient," Innov Pharm, vol. 12, no. 4, pp. 4341, 2021. DOI:10.24926/iip. v12i4.4341

[15] T. Bellón, V. Lerma, J. Guijarro, E. Ramírez, C. Martinez, C. Escudero, et al., "LTT and HLA testing as diagnostic tools in Spanish vancomycin-induced DRESS cases: A case-control study," Front Pharmacol, vol. 13, pp. 959321, 2022. DOI:10.3389/fphar.2022.959321

[16] R. Ancos-Pintado, I. Bragado-García, M. Morales, R. García-Vicente, A. Arroyo-Barea, A. Rodríguez-García, et al., "High-throughput CRISPR screening in hematological neoplasms," Cancers, vol. 14, no. 15, pp. 3612, 2022. DOI:10.3390/cancers14153612

[17] Y. Yin, J. Lan, and Q. Zhang, "Application of high-throughput next-generation sequencing for HLA typing on buccal extracted DNA," Methods Mol Biol, vol. 1802, pp. 101-113, 2018. DOI:10.1007/978-1-4939-8546-3_7

[18] C. Morán-Mariños, C. Alva-Díaz, W. D. Ramirez, A. Quincho-Lopez, N. Mori, J. Pacheco-Mendoza, et al., "Drug reaction with eosinophilia and systemic symptoms (DRESS) induced by phenytoin re-exposure: case report and systematic review," Acta Clin Belg, vol. 77, pp. 177-185, 2020. DOI:10.1080/17843286.2020.1767459

[19] A. Chowdhury, N. Jahan, I. A. Temitope, and S. Wang, "Current etiological comprehension and therapeutic targets of acetaminophen-induced hepatotoxicity," Pharmacol Res, vol. 160, pp. 105102, 2020. DOI: 10.1016/j.phrs.2020.105102

[20] M. Lyttle, N. Rainford, C. Gamble, S. Messahel, A. Humphreys, H. Hickey, et al., "Levetiracetam versus phenytoin for second-line treatment of paediatric convulsive status epilepticus (EcLiPSE): a multicentre, open-label, randomised trial," Lancet, vol. 393, pp. 2125-2134, 2019. DOI:10.1016/S0140-6736(19)30724-X

[21] J. Sanabria-Cabrera, S. Tabbai, H. Niu, I. Álvarez-Álvarez, A. Licata, E. Björnsson, et al., "N-Acetylcysteine for the Management of Non-Acetaminophen Drug-Induced Liver Injury in Adults: A Systematic Review," Front Pharmacol, vol. 13, pp. 876868, 2022. DOI:10.3389/fphar.2022.876868

[22] F. Firozian, S. Karami, A. Ranjbar, M. T. Azandaryani, and A. Nili-Ahmadabadi, "Improvement of therapeutic potential N-acetylcysteine in acetaminophen hepatotoxicity by encapsulation in PEGylated nano-niosomes," Life Sci, vol. 260, pp. 117832, 2020. DOI: 10.1016/j.lfs.2020.117832

[23] O. Bane, S. J. Hectors, S. Gordic, P. Kennedy, M. Wagner, A. Weiss, et al., "Multiparametric magnetic resonance imaging shows promising results to assess renal transplant dysfunction with fibrosis," Kidney Int, vol. 97, no. 2, pp. 414-420, 2020. DOI: 10.1016/j.kint.2019.09.030

[24] E. Carlton, J. Close, K. Paice, A. Dews, S. M. Gorga, J. M. Sturza, et al., "Clinician accuracy in identifying and predicting organ dysfunction in critically ill children," Crit Care Med, vol. 48, pp. e1012-e1019, 2020. DOI:10.1097/CCM.0000000000004555

[25] P. Vollmuth, M. Foltyn, R. Y. Huang, N. Galldiks, J. Petersen, F. Isensee, et al., "AI-based decision support improves reproducibility of tumor response assessment in neuro-oncology: an international multi-reader study," Neuro-Oncol, vol. 24, no. 1, pp. e87, 2022. DOI:10.1093/neuonc/noac189

[26] F. Shaikh, J. Dehmeshki, S. Bisdas, D. Roettger-Dupont, O. Kubassova, M. Aziz, et al., "Artificial intelligence-based clinical decision support systems using advanced medical imaging and radiomics," Curr Probl Diagn Radiol, vol. 49, no. 4, pp. 190-202, 2020. DOI: 10.1067/j.cpradiol.2020.05.006

[27] A. Ahmad, M. Corban, T. Toya, Z. Attia, P. Noseworthy, M. Cohen, et al., "Artificial intelligence-enabled detection of paroxysmal atrial fibrillation from normal sinus ECGs in patients with coronary microvascular dysfunction," Eur Heart J, vol. 41, no. 4, pp. e1273, 2020. DOI:10.1093/ehjci/ehaa946.1265

[28] M. R. McCann, M. V. G. de la Rosa, G. R. Rosania, and K. A. Stringer, "L-carnitine and acylcarnitines: mitochondrial biomarkers for precision medicine," Metabolites, vol. 11, no. 1, pp. 51, 2021. DOI:10.3390/metabo11010051

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3457-3464, 2024
DOI: 10.55214/25768484.v8i6.2731