AJCM
Avicenna Journal of Clinical Medicine

Avicenna J Clin Med, 2026; 33(1): 39-45 Doi: 10.53208/ajcm.33.1.39
https://sjh.umsha.ac.ir

Original Article

Oxidative Stress and Antioxidant Defense in Infants with Respiratory Distress Syndrome

Nesa Mafakheri[1], Fatemeh Eqbalian[1,3], Homa Naderifar[1], Roya Najafi Vosough[2], Mohammad Kazem Sabzei[3], Fereshteh Mehri[4*]

[1] Hearing Disorders Research Center, Avicenna Institute of Clinical Sciences, Hamadan University of Medical Sciences, Hamadan, Iran
[2] Research Center for Health Sciences, Institute of Health Sciences and Technologies, Hamadan University of Medical Sciences, Hamadan, Iran
[3] Department of Pediatrics, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Iran
[4] Nutrition Health Research Center, Institute of Health Sciences and Technologies, Hamadan University of Medical Sciences, Hamadan, Iran

Article history:
Received: 01 February 2026
Revised: 30 March 2026
Accepted: 06 May 2026
ePublished: 15 June 2026

Copyright © 2026 The Author(s); Published by Hamadan University of Medical Sciences. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

BRIEF TEXT

Background and Objective

Pulmonary diseases are among the leading causes of neonatal mortality worldwide, particularly in developing countries [1]. Several risk factors, including cesarean section, male gender, gestational diabetes, preterm birth, and lung infection, are associated with neonatal respiratory distress syndrome (RDS) [2]. … [3]. Transient tachypnea of the newborn occurs in approximately 10% of infants born at 33–34 weeks and 5% of those born at 35–36 weeks, with a higher prevalence in preterm infants; RDS may coexist in these cases [4]. The etiology of pulmonary diseases in newborns depends on the infant's age, source of infection, season, and medical or environmental risk factors. Although the mechanisms of lung injury in neonatal respiratory diseases are not completely understood, oxidative stress (OS) is considered an important contributor to their pathophysiology [5]. OS results from an imbalance between free radicals and intracellular antioxidant defenses, leading to cellular and tissue damage through interactions with proteins, lipids, and DNA [6]. The use of reliable diagnostic techniques and strategies that support the neonatal immune system may help prevent adverse outcomes and improve respiratory health in preterm infants [7]. … [8–9]. Therefore, measuring oxidative stress at the molecular level, including lipid, protein, and DNA oxidation, is essential [10]. Given previous evidence and the high risk of respiratory disease, this study aimed to evaluate oxidant and antioxidant parameters in newborns with RDS admitted to the neonatal intensive care unit (NICU) of Fatemieh Hospital and to use the findings to guide protective care strategies.

Materials and Methods

This case-control study included 24 healthy infants and 24 infants with RDS admitted to the NICU at Fatemieh Hospital in Hamadan, Iran, in 2024. The diagnosis of RDS was based on typical clinical and radiological findings, including tachypnea, cyanosis, need for mechanical ventilation hours after birth, and characteristic chest X-ray patterns. The control group consisted of infants without respiratory symptoms who did not require hospitalization during the first days after birth and were generally healthy, typically those referred for thyroid screening. Ethical approval for this study was obtained from the Ethics Committee of Hamadan University of Medical Sciences (IR.UMSHA.REC.1403.370). For all participants, two milliliters of peripheral blood were collected in heparinized tubes under sterile conditions. The total antioxidant capacity (TAC) and malondialdehyde (MDA) levels were measured using ELISA kits provided by Kiazyst Company. Data were collected using a researcher-designed checklist including demographic information, birth details, maternal and neonatal medical history, medications, type of delivery, hospitalization history, summary of clinical findings, lung auscultation, breathing pattern, and initial vital signs. The exclusion criteria included neonatal infection, metabolic disease, genetic disorders, difficult delivery, and fetal distress.

Extended Abstract

Results

Low-birth-weight infants with RDS were considered patients, and healthy, normal-weight infants without RDS or respiratory manifestations were considered controls. Table 1 summarizes the characteristics of mothers and infants participating in this study. The RDS group consisted of 24 premature low birth weight infants with a mean gestational age of (29.4 ± 4.1) weeks and a mean birth weight of 1340 ± 143 g. The control group consisted of 24 normal birth weight infants with a mean gestational age of 37.2 ± 1.6 weeks and a mean birth weight of 2870 ± 185 g. Table 2 presents the concentrations of oxidative damage markers and total antioxidant status in the blood of infants with respiratory distress syndrome compared with the control group. Significant differences were assessed by the Student's t-test with equal variances. According to the results (TAC), the value in the respiratory distress group was significantly lower (50.300) than that in the control group. Also, lipid peroxidation (MDA) levels in the respiratory distress group were significantly higher (37.333) than in the control group.

Discussion

The findings of this study indicated a significant increase in MDA levels and a decrease in TAC in infants with respiratory distress syndrome compared to the control group, highlighting the important role of oxidative stress in the pathophysiology of the disease [11]. ... [12]. Oxidative stress is a recognized feature of the inflammatory response to various viral infections. When the human body is confronted with a viral pathogen, various immune cells, including neutrophils and macrophages, produce ROS as part of their defense mechanisms [13]. ... [14-16]. In a parallel study conducted in neonates by Pavlyshyn et al. in 2018, they found that in neonates with pneumonia, a prooxidant activation response occurred, manifested by a significant increase in oxidatively modified proteins and DNA fragmentation. They also concluded that fluctuations in oxidative stress indices are associated with the severity of the disease [17]. ... [18-25]. The findings of this study also have important implications for potential therapeutic strategies to manage respiratory viral infections in neonates. Since oxidative stress appears to play an important role in the pathogenesis of the disease, interventions aimed at reducing oxidative stress or enhancing antioxidant defenses could offer new treatment approaches. Several studies have investigated the therapeutic use of antioxidants, such as vitamin C, vitamin E, and N-acetylcysteine, in respiratory infections, with promising results in reducing oxidative damage and improving lung function [26]. However, further clinical trials are needed to evaluate the safety and efficacy of antioxidant therapy in neonates with respiratory viral infections. Furthermore, addressing oxidative stress early in the disease process may reduce the risk of long-term pulmonary complications, such as chronic obstructive pulmonary disease, which can result from repeated or severe viral infections in infancy [27].

Conclusion

The results of this study indicate that oxidative stress is evident in newborns with RDS, as reflected by increased MDA levels and decreased TAC. These findings highlight the potential of oxidative stress as a therapeutic target in neonatal viral respiratory infections.

REFERENCES

1. Hasanuzzaman M, Bhuyan MHMB, Zulfiqar F, Raza A, Mohsin SM, Mahmud JA, et al. Reactive oxygen species and antioxidant defense in plants under abiotic stress: revisiting the crucial role of a universal defense regulator. *Antioxidants (Basel).* 2020;9(8). Link
2. Yue LY, Yan. Metabolic regulation in acute respiratory distress syndrome: implications for inflammation and oxidative stress. *Int J Chron Obstruct Pulmon Dis.* 2025;373-388. PMID: PMC11846517
3. Bardají-Carrillo M, et al. Epidemiological trends of mechanically ventilated acute respiratory distress syndrome in the twenty-first century: a nationwide, population-based retrospective study. *J Intensive Care.* 2025;13(1):9. PMID: 39962546
4. He Y. Clinical management and outcomes of respiratory distress syndrome in preterm infants <32 weeks' gestation from the Chinese Neonatal Network from 2019 to 2023. *Zhonghua Er Ke Za Zhi.* 2025;63(8):870-878. PMID: 40692458
5. Wang F. Oxidative stress in ARDS: mechanisms and therapeutic potential. *Front Pharmacol.* 2025;16:1603287. PMID: 40642004

6. Perrone S, Tataranno ML, Buonocore G. Oxidative stress and bronchopulmonary dysplasia. *J Clin Neonatol.* 2012;1(3):109. PMID: PMC3762019
7. Inayat M. Antioxidants and biomarkers of oxidative stress in preterm infants with symptomatic patent ductus arteriosus. *Am J Perinatol.* 2015;32(9):895-904. PMID: 25715313
8. McClintock CR, Mulholland N, Krasnodembskaya AD. Biomarkers of mitochondrial dysfunction in acute respiratory distress syndrome: a systematic review and meta-analysis. *Front Med.* 2022;9:1011819. PMID: 36590959
9. Pericás MC, Escobar J, Vento M. Oxygen and oxidative stress in the perinatal period. 2017. Link
10. Hussain T. Oxidative stress and inflammation: what polyphenols can do for us? *Oxid Med Cell Longev.* 2016;2016. PMID: 27738491
11. Xu W, Zhao T, Xiao H. The implication of oxidative stress and AMPK-Nrf2 antioxidative signaling in pneumonia pathogenesis. *Front Endocrinol.* 2020;11:400. PMID: 32625169
12. Schieber M, Chandel NS. ROS function in redox signaling and oxidative stress. *Curr Biol.* 2014;24(10):R453–R462. PMID: 24845678
13. Lee C. Therapeutic modulation of virus-induced oxidative stress via the Nrf2-dependent antioxidative pathway. *Oxid Med Cell Longev.* 2018;2018(1):6208067. PMID: 30515256
14. Hecker L. Mechanisms and consequences of oxidative stress in lung disease: therapeutic implications for an aging populace. *Am J Physiol Lung Cell Mol Physiol.* 2018;314(4):L642–L653. PMID: 29351446
15. Yurdakök M. Transient tachypnea of the newborn: what is new? *J Matern Fetal Neonatal Med.* 2010;23(Suppl 3):24–26. PMID: 20807157
16. Ighodaro O, Akinloye O. First-line defence antioxidants—superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX): their fundamental role in the entire antioxidant defence grid. *Alex J Med.* 2018;54(4):287–293. Link
17. Pavlyshyn H, Kibar V, Slyva V. Oxidative stress manifestation for community-acquired pneumonia in children living in endemic areas of iodine deficiency. *Acta Medica.* 2018;49(3):24–29. Link
18. Chatterjee S. Oxidative stress, inflammation, and disease. *Oxidative Stress and Biomaterials.* Amsterdam: Elsevier; 2016. p. 35–58. Link
19. Zamparelli SS, Zamparelli AS, Bocchino M. Immune-boosting and antiviral effects of antioxidants in COVID-19 pneumonia: a therapeutic perspective. *Life (Basel).* 2025;15(1):113. PMID: 39860053
20. Carr A. Patients with community-acquired pneumonia exhibit depleted vitamin C status and elevated oxidative stress. *Nutrients.* 2020;12:1318. PMID: 32384616
21. Hamid ERA, et al. Oxidative stress and anti-oxidant markers in premature infants with respiratory distress syndrome. *Open Access Maced J Med Sci.* 2019;7(17):2858. PMID: 31844449
22. Sorrentino L. NRF2 antioxidant response and interferon-stimulated genes are differentially expressed in respiratory-syncytial-virus- and rhinovirus-infected hospitalized children. *Pathogens.* 2023;12(4):577. PMID: 37111463.
23. Kaltsogianni O, Dassios T, Greenough A. Oxidant stress, hyperoxia/hypoxia and neonatal respiratory disorders. *Antioxidants.* 2025;14(12):1389. Link
24. Shaaban HA. The effect of ventilatory supports on oxidative stress biomarkers in preterm respiratory distress. *Ain Shams Med J.* 2024;75(4):988-998. Link
25. Moreno-Solís G, et al. Oxidative stress and inflammatory plasma biomarkers in respiratory syncytial virus bronchiolitis. *Clin Respir J.* 2017;11(6):839-846. PMID: 26663823
26. Santus P. Oxidative stress and respiratory system: pharmacological and clinical reappraisal of N-acetylcysteine. *COPD.* 2014;11(6):705-717. PMID: 24787454
27. Barson WJ, Kaplan S, Torchia M. Pneumonia in children: epidemiology, pathogenesis, and etiology. *UpToDate.* Waltham, MA. 2018. Link

Table 1. Mothers and Infants Characteristics

Characteristics	RSD Group n = 24	Control Group n = 24	*P* Value
Maternal age (y)	26 ± 3	24 ± 2	0.14
Gravida, No. (%)			
Primigravidas	10 (41.6)	14 (58.3)	0.63
Multigravidas	14 (58.3)	12 (47.3)	
Mode of delivery, No. (%)			
Vaginal delivery	9 (37.5)	7 (29.1)	0.54
Cesarean section	15 (62.5)	17 (70.83)	
Sex, No. (%)			
Males	8 (3.33)	9 (37.5)	0.21
Females	16 (6.66)	17 (70.8)	
Gestational age (weeks)	29.4 ± 1.4	38.2 ± 1.6	0.000

Birth weight (g)	1340 ± 143	11670 ± 185	0.000
Apgar score			
1 min	6.52 ± 1.6	8	0.000
2 min	7.41 ± 1.8	9	0.000

Table 2. Comparison of Two Groups in Terms of Oxidative Stress Tests

Biomarker	RDS Group	Control Group	*P* Value
TAC (nmol eq of Trolox/mL)	50.300	161.20	0.0001
MDA (nmol/mL)	37.333	12.267	0.0001