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ORIGINAL ARTICLE

Significant preservation of the heart in human body extremely destroyed by the fire

Filip Babiak[1], Katarína Hanzelyová[1], Richard Sivulič[1,2], Paulína Martináková[1,2], Ľubomír Straka[1,2], Martin Janík[1,2]

[1]Department of Forensic Medicine and Medicolegal Expertise, Jessenius Faculty of Medicine, Comenius University, University Hospital, Martin, Slovakia
[2]Forensic and Pathological-Anatomical Unit, Health Care Surveillance Authority, Martin, Slovakia

SUMMARY

Fire-related fatalities often result in extensive thermal destruction of human remains, posing significant challenges for forensic analysis. Although soft tissues are generally destroyed during exposure to high temperatures, rare cases may reveal selective internal organ preservation. This case report describes two individuals recovered from a recreational cabin fire in northern Slovakia, where most bodily structures were extensively carbonized and fragmented. Remarkably, the heart exhibited an intact internal morphology despite external carbonization. Macroscopic examination revealed preserved myocardium, distinguishable valve structures and voluminous cooked blood within the cardiac chambers. The pericardial sac and epicardial layer including coronary vasculature were thermally destroyed and thus non-evaluable. The preserved state of this organ, amid widespread anatomical destruction, suggests a thermal buffering mechanism mediated by retained blood and the histomorphological structure of the heart. This case underscores the importance of thoroughly examining severely burned remains, as preserved internal tissues may yield critical insights, contributing to the accurate reconstruction of death circumstances in fire-related fatalities.

Keywords: carbonization – fire-related death – thermal injury – heart – autopsy

Signifikantné uchovanie srdca pri extrémnej termickej deštrukcii ľudského tela

SOUHRN

Úmrtia v dôsledku požiarov často vedú k rozsiahlej termickej deštrukcii ľudských pozostatkov, čo predstavuje výzvu pre forenznú antropologickú analýzu. Vysoké teploty zvyčajne spôsobujú úplnú karbonizáciu mäkkých tkanív a výrazne degradujú aj kostné tkanivo, čím sťažujú aplikáciu štandardných identifikačných a vyšetrovacích postupov. Napriek tomu, že mäkké tkanivá sú pri vystavení vysokým teplotám spravidla veľmi ťažko morfologicky hodnotiteľné, v špecifických prípadoch a podmienkach môže dôjsť k selektívnemu zachovaniu vnútorných orgánov. Táto kazuistika popisuje dvoch jedincov nájdených po požiari rekreačnej chaty na severe Slovenska, kde bola väčšina telesných pozostatkov zuhoľnatená a fragmentovaná. Pozoruhodné však je, že srdce si napriek vonkajšej karbonizácii zachovalo pôvodnú anatomickú celistvosť a morfológiu. Pri makroskopickom vyšetrení bol zreteľne zachovaný myokard (kompaktná aj trabekulárna časť vrátane papilárnych svalov), endokard a chlopňový aparát vrátane cípov chlopní a ich úponov. V srdcových dutinách sa nachádzalo objemné množstvo termicky modifikovanej krvi. Perikard a epikard vrátane koronárnych tepien bol termicky deštruovaný a nehodnotiteľný. Zachovanie vnútorných štruktúr srdca, napriek rozsiahlej termickej deštrukcii tela vrátane celého skeletu, poukazuje na pôsobenie termoprotektívneho efektu, súvisiaceho s prítomnosťou tekutiny (krvi) v srdcových dutinách a histologickou stavbou srdcového tkaniva. Tento prípad zdôrazňuje význam dôkladného post-mortem vyšetrenia zuhoľnateného ľudského telo následkom požiaru, pretože zachované vnútorné štruktúry môžu poskytovať kľúčové informácie prispievajúce k presnej rekonštrukcii okolností úmrtia pri požiaroch.

Kľúčové slová: zuhoľnatenie tela – úmrtie pri požiari – termické poškodenie – srdce – pitva

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Fatalities resulting from fire are a frequent finding in forensic casework, however, the investigation of such deaths presents a range of forensic complexities and interdisciplinary investigative demands. Human bodies exposed to fire often suffer extensive thermal injury and post-mortem environmental interference, both of which hinder the preservation of forensic evidence and complicate the accurate interpretation of peri-mortem events (1-3).

Although fire has the capacity to destroy both soft tissue and the underlying skeletal structures, complete incineration of a human body is rare and typically achievable only under highly specific and controlled conditions. These include scenarios such as cremation, prolonged exposure to high-temperature fires or open-air pyres maintained over extended durations (4,5). These limitations can create confusion among law enforcement officers, fire investigators and forensic practitioners when encountering cases where a body appears almost entirely consumed by fire.

The analysis of burned human remains presents multiple challenges in both the recovery and laboratory stages. High-intensity heat causes significant physical alterations. These changes can impede both macroscopic and microscopic evaluations, complicating standard procedures for biological profiling, such as sex estimation, age assessment and stature reconstruction, as well as DNA and toxicological analysis (6). Recovery at the scene is further hindered by the morphological resemblance of burned biological and inorganic remnants, increasing the likelihood of overlooking or misidentifying critical evidence. Such difficulties can ultimately obscure determinations regarding peri-mortem trauma, delay victim identification and undermine efforts to accurately establish the cause and manner of death (7,8). Therefore, meticulous collection and safeguarding of every fragment and every piece of evidence, no matter how

✉ ***Correspondence address:***
RNDr. Katarína Hanzelyová
Department of Forensic Medicine and Medicolegal Expertise, Jessenius Faculty of Medicine, Comenius University Bratislava
Kollárova 2, 03601 Martin
Slovakia
tel.: +421 918 389 384
e-mail: hanzelyova7@uniba.sk

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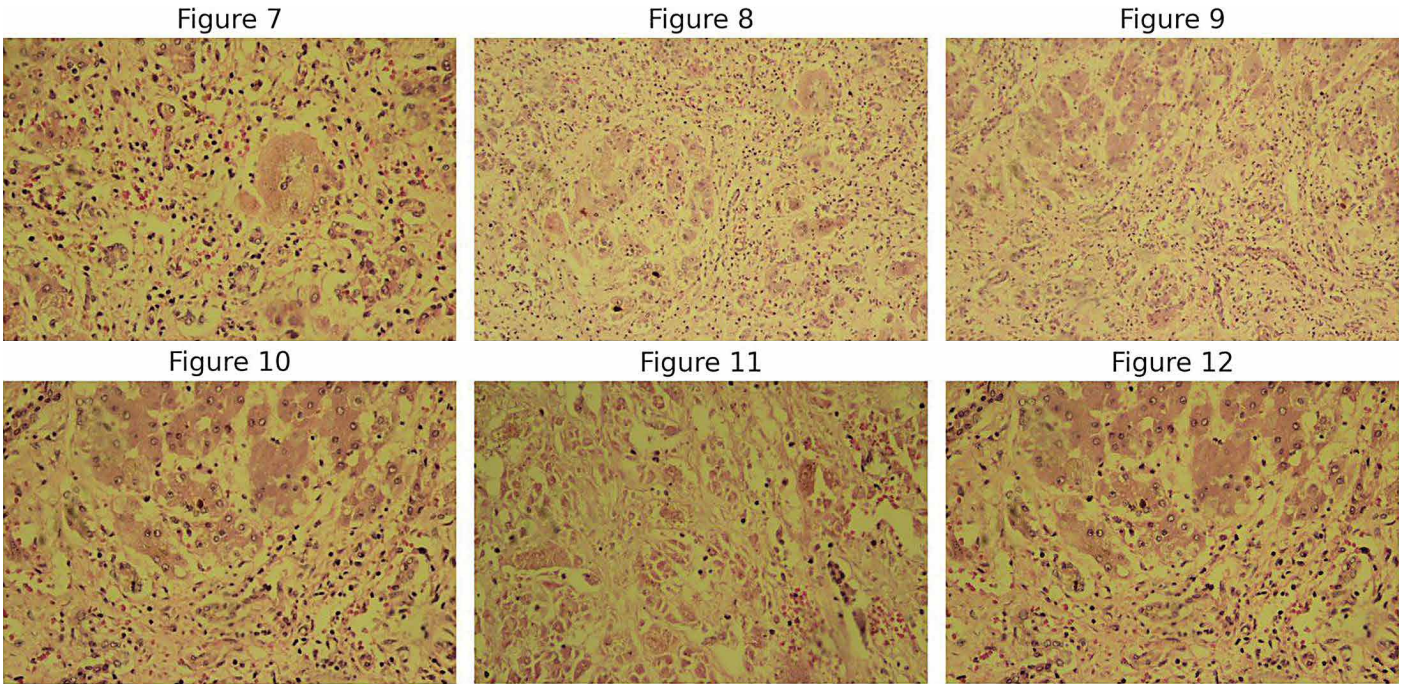


Figure 5. Microscopic view of the liver. Grid 2 (Figures 7–12): shows prominent areas of cholestasis, extramedullary hematopoiesis, and periportal changes.

When parents are provided with a clear explanation of the autopsy results in cases where the diagnosis is established but the exact cause of death remains uncertain, it often helps them come to terms with the loss of their infant. The findings should be communicated in language that parents can comprehend, illustrating how these results contribute to clarifying the cause of death. Moreover, the forensic pathologist ought to take the time to answer parents' questions with compassion, respect, and sensitivity to their grief and dignity (20).

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

REFERENCES

1. **Anochin VA, Gumerova AA.** Viral hepatitis in the structure of perinatal infections. *Russian Pediatric Journal* 2002; 2: 32–34.
2. **Kaganov BS.** Pediatric Hepatology. Moscow: Dinastiya; 2009: 575.
3. **Orekhov KV.** Intrauterine infections. Moscow: Medpraktika-M; 2002: 252.
4. **Gallegos-Orozco JF, Rakela-Brödner J.** Hepatitis viruses: they are not always what they seem. *Rev Med Chil* 2010; 138(10): 1302–1311.
5. **Korovina NA., Zaplatnikov AL, Cheburkin AV, et al.** Cytomegalovirus infection in young children (clinic, diagnosis, current treatment options). A guide for doctors. Moscow: Medpraktika; 2001: 64.
6. **Yatsik GV, Odinayeva ND, Belyavova IA.** Cytomegalovirus infection. *Pediatric Practice. Doctor's Reference* 2009; 10: 5–12.
7. **Lauren N, Kimberlin D, Whitley R.** Treatment of congenital cytomegalovirus infection: implications for future therapeutic strategies. *J. Antimicrob Chemother* 2009; 63(5): 862–867.
8. **Latifa TF, Yeng, Susan M, Eve AR.** Mother-to-child transmission of hepatitis C virus. *Hepatology* 2001; 34: 223–229.
9. **Leung AK, Sauve RS, Davies HD.** Congenital cytomegalovirus infection. *J Natl Med Assoc* 2003; 95(3): 213–218.
10. **Degtyareva AV, Muchina YuG, Degtyarev DN.** Cholestasis syndrome in newborns. A guide for physicians. Moscow: Scientific Center for Obstetrics, Gynecology, and Perinatology V.I. Kulakov, Russian Medical University N.I. Pirogov; 2011: 36.
11. **Kudashov NI.** Cytomegalovirus infection in newborns: diagnosis and treatment. *Attending Physician* 2006; 3: 73–78.
12. **Ozhegov AM, Maltsev SV, Myakisheva LS.** Clinical-immunological features of active cytomegalovirus and mixed infections in infants. *Pediatrics* 2001; 2: 26–31.
13. **Hasosah MY, Kutbi SY, Al-Amri AW, et al.** Perinatal cytomegalovirus hepatitis in Saudi infants: a case series. *Saudi J Gastroenterol* 2012; 18(3): 208–213.
14. **Lombardi G, Garofoli F, Stronati M.** Congenital cytomegalovirus infection: treatment, outcomes, and follow-up. *J Matern Fetal Neonatal Med* 2010, 23(3): 45–48.
15. **Kovalova TA, Chuykova KI, Evtushenko ID, Mukhachova OG.** Vertical transmission of hepatitis B and C viruses during pregnancy: prevention options. *Gynecology* 2011; 13(2): 24–28.
16. **Mayer KP.** Hepatitis and its consequences. Moscow: Geotar-Media; 1999: 432.
17. **Basaraba N.** Congenital hepatitis: modern approaches to diagnosis and prevention. *Perinatology and Pediatrics* 2009; 4: 79–83.
18. **Seredenin SB.** Lectures on Pharmacogenetics. Moscow: MIA; 2004: 301.
19. **Sopkova D, Farkasova Iannaccone S.** Essentials of neonatal autopsy. *Folia societatis medicinae legalis Slovacae* 2018; 8(1): 16–19.
20. **Vyhnalkova V, Baloghova A, Farkasova Iannaccone S.** The latest studies on SIDS. *Folia societatis medicinae legalis Slovacae* 2011; 1(11): 92–100.

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Internal examination:

Both pleural cavities contained 30 ml of transudate. The lungs (right – 44 g, left – 41g) were compact and pale. The abdominal cavity contained 250 ml of fresh blood and 25 g of coagulated blood. The liver (10 × 5.5 × 2 cm, 90 g) was age-appropriate in size, with adequate consistency, preserved vascular network, normal anatomical structure, and rounded edges. The surface was nodular. On section, the liver tissue showed multiple gray-white round lesions measuring 0.1–0.4 cm in diameter, interspersed with visible necrotic foci (Figure 3). The spleen (8 × 5.5 × 2 cm, 50 g) was pathologically enlarged, with a smooth, shiny, soft dark purple surface and firm consistency; the edges were rounded and did not adhere to surrounding tissues. On section, the tissue appeared edematous.

Other organs and systems showed no macroscopic changes.

Interpretation of Autopsy Findings and Conclusion

Microscopic examination of internal organs using Gram staining revealed the following:

- Lungs: Large and small bronchi lined with flat epithelium; bronchial mucosa preserved but infiltrated with lymphocytes. Bronchial and respiratory bronchiole lumens contained exudates. Alveoli showed hemosiderin deposits and desquamated alveolocytes. Pulmonary vessels had typical histological structure; fibrin deposits with signs of organization were found in the lumens.
- Liver: Giant cell transformation, focal necrosis with hepatocellular cholestasis, alternating portal mononuclear inflammatory infiltrates. Extramedullary hematopoiesis was also present (Figure 4, 5).
- Brain: Pericellular and perivascular edema, numerous blood vessels, areas of periventricular leukomalacia, and extravascular hemorrhages.

Based on the results of the autopsy (both macroscopic and microscopic findings), the diagnosis was: Idiopathic neonatal hepatitis.

The immediate cause of death was a perinatal hematological disorder resulting in hemorrhagic shock.

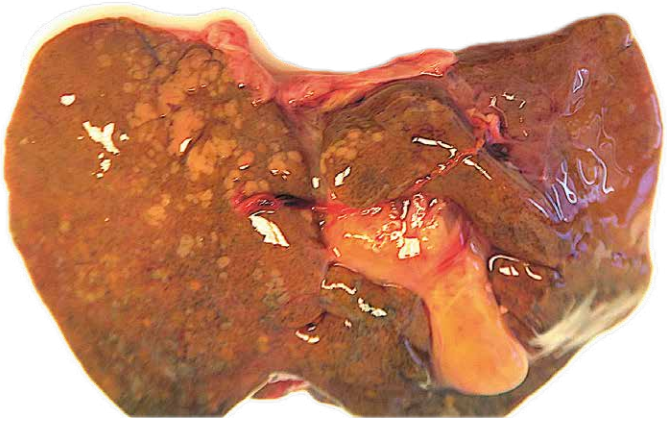


Figure 3. Macroscopic view of the liver.

CONCLUSION

Risk factors for the development of neonatal hepatitis include: advanced maternal age, history of spontaneous or medical abortions, various inflammatory diseases of the urogenital system, anemia of varying severity, and low birth weight of the newborn.

The source of infection leading to the development of neonatal hepatitis is usually the mother, particularly in the presence of urogenital inflammatory diseases and various infections confirmed by ELISA test results.

The main diagnostic criteria for neonatal hepatitis are: hemorrhagic syndrome with liver involvement (confirmed by clinical, laboratory, and imaging studies), hepatolienal syndrome, and anemia of varying degrees – particularly moderate to severe anemia.

Collecting data from infants' medical records, the frequency and thoroughness of autopsies performed on premature or full-term newborns and infants, as well as the interpretation of the findings, often reveal the most significant shortcomings in the practice of newborn autopsy. (19).

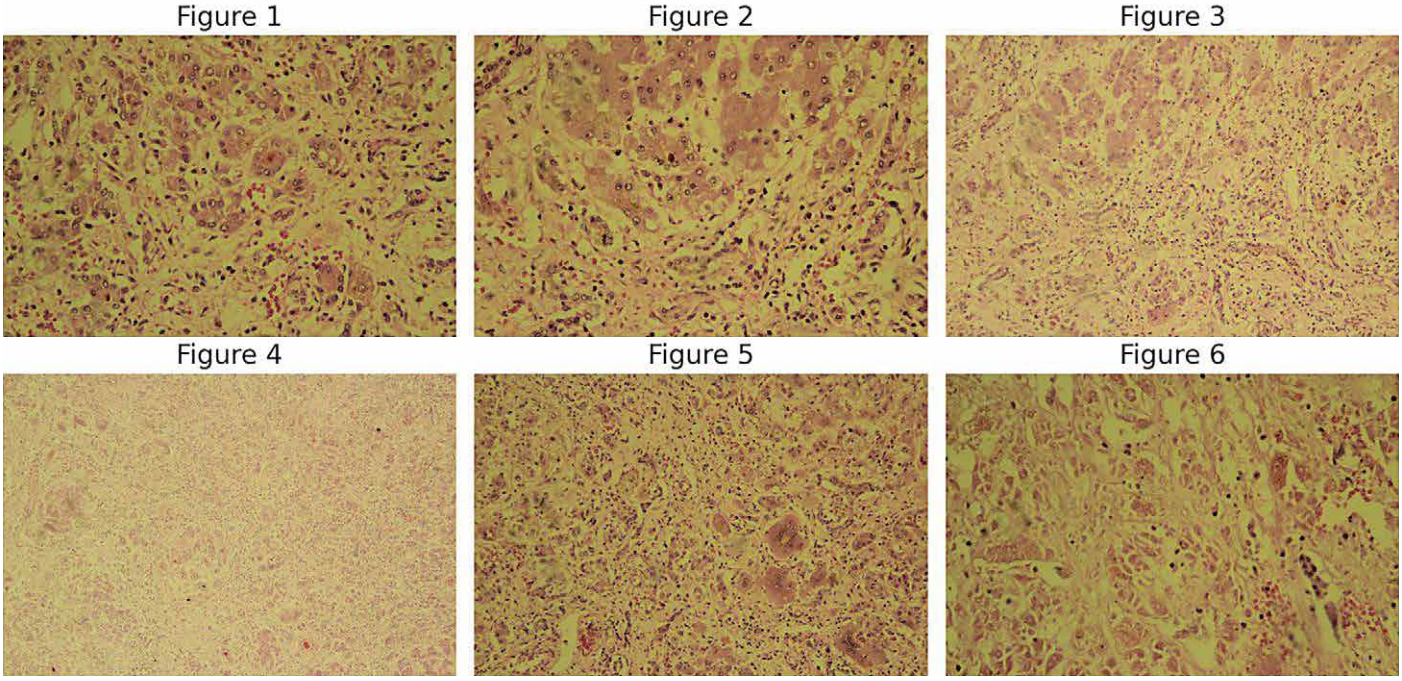


Figure 4. Microscopic view of the liver. Grid 1 (Figures 1–6): demonstrates giant cell transformation, necrotic foci, and inflammatory infiltrates.

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According to various authors, an infectious origin of the disease can be confirmed in 10–45.9% of newborns with NH (17). When the etiology of NH remains unclear, the term "idiopathic NH" is used (a group of undiagnosed infectious and non-infectious diseases). It is known that several inherited metabolic disorders can mimic NH, including disorders of amino acid metabolism (e.g., tyrosinemia), carbohydrates (e.g., galactosemia), bile acids (e.g., Byler syndrome), lipids (e.g., Gaucher disease, Niemann-Pick type C), as well as arginase deficiency, α1-antitrypsin deficiency, mucopolysaccharidoses, hemochromatosis, etc. (2,10). Since metabolic disorders can manifest in the neonatal period, it is important to consider both infectious and metabolic causes of liver pathology. Other potential non-infectious causes of NH include drug-induced liver injury. Hepatotoxicity may result from antibacterial agents (macrolides, antituberculotics, antifungals), non-steroidal anti-inflammatory drugs (paracetamol, diclofenac), and others. In neonates, immature functional systems – such as low levels of cytochrome P450, glutathione peroxidase, glutathione-S-transferase, and other liver enzymes – can contribute to the development of drug-induced hepatopathy (18).

Gathering the information from medical records of the infant, the extent to which the autopsies of premature or mature newborns and infants are conducted, and sometimes even the interpretation of the actual findings represent the most highlighted deficiencies.

CASE REPORT

A newborn girl from the third pregnancy was delivered at 36 weeks of gestation via cesarean section due to intrauterine growth restriction and breech presentation. The prenatal course was complicated by suspected gestational pemphigoid, treated with corticosteroids. Postnatal adaptation was adequate; however, on the 4th day of life, the patient was transferred to the neonatal clinic due to signs of congenital hepatopathy, hypocoagulation, and thrombocytopenia.

Laboratory tests confirmed severe liver dysfunction (hypoalbuminemia, hyperbilirubinemia, elevated ferritin, coagulopathy) as well as metabolic dysregulation (hypoglycemia, hypokalemia, lactic acidosis). Infectious causes were ruled out by PCR testing (CMV, EBV, HSV, Parvovirus B19, HCV – all negative). Screening for inherited metabolic diseases was inconclusive. Due to suspected GALD (gestational alloimmune liver disease), IVIG was administered and exchange transfusion was performed. Despite these interventions, hepatic failure, pancytopenia, and edema progressed.

Bone marrow examination confirmed hypocellularity without signs of malignancy. Liver ultrasound revealed hepatosplenomegaly with hyperechogenicity. Following a liver biopsy, the patient's condition suddenly deteriorated due to the development of intra-abdominal hemorrhage. CT imaging confirmed active subcapsular bleeding from the liver. Intensive resuscitation, coagulation support, surfactant therapy, and high-frequency oscillatory ventilation (HFOV) were unsuccessful. The infant died at the age of 26 days.

Autopsy Findings

An autopsy was performed on January 2, 2025.

External examination:

A live-born female infant, body length 52 cm, weight 4700 g. The anterior abdominal wall was enlarged and bulging above the chest level due to fluid accumulation in the abdominal cavity. There was pronounced swelling of the lower limbs (Figures 1, 2).



Figure 1. External view of the infant – front view.



Figure 2. External view of the infant – rear view.

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Idiopathic Neonatal Hepatitis: Clinical and Pathomorphological Analysis

Roman Hai[1], Ján Bajaj[1], Jakub Bízik[2], Filip Babiak[1,2], Martin Janík[1,2], Ľubomír Straka[1,2]

[1] Súdnolekárske a patologicko-anatomické pracovisko, Úrad pre dohľad nad zdravotnou starostlivosťou, Martin, Slovenská republika.
[2] Ústav súdneho lekárstva a medicínskych expertíz, Jesseniova lekárska fakulta, Univerzita Komenského v Bratislave, Univerzitná nemocnica Martin, Martin, Slovenská republika.

SUMMARY

Neonatal hepatitis is a rare but serious liver disease in infants during the first year of life. The term "neonatal hepatitis" refers to infectious liver damage that develops either in utero or during the first three months after birth. The timing of disease onset varies significantly depending on the etiology and is determined by the gestational period during which the fetus was infected as well as the incubation period. Therefore, in some cases, symptoms may appear almost immediately after birth, and in others – weeks or even months later.

Keywords: Neonatal hepatitis – infectious liver damage – infants

Idiopatická neonatálna hepatitída: klinická a patomorfologická analýza

SOUHRN

Novorodenecká hepatitída je zriedkavé a však závažne ochorenie pečeni u dojčiat v prvom roku života. Termín „neonatálna hepatitída" označuje infekčné poškodenie pečene, ktoré sa vyvinie buď in utero, alebo počas prvých troch mesiacov po narodení. Načasovanie nástupu hepatitídy sa výrazne líši v závislosti od etiológie a je určené gestačným obdobím, počas ktorého bol plod infikovaný, ako aj dĺžkou inkubačnej doby. Z tohto dôvodu sa v niektorých prípadoch príznaky NH objavia takmer okamžite po narodení, zatiaľ čo v iných - týždne alebo dokonca mesiace neskôr. Je jedným z najpálčivejších problémov u dojčiat počas prvého roku života.

Kľúčová slová: novorodenecká hepatitída – infekčné poškodenie pečene – dojčatá

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Neonatal hepatitis (NH) is one of the most significant problems in children during the first year of life. The term "neonatal hepatitis" refers to infectious liver damage that develops intrauterinely or during the first three months after birth. The time of hepatitis onset varies significantly depending on the etiology and is determined by the gestational age at which fetal infection occurred and by the length of the incubation period. For this reason, in some cases, symptoms of NH appear almost from birth, while in others – only after weeks or months. The causes leading to the development of NH are diverse (1,2,3,4).

Liver damage in newborns most often occurs due to viral infections caused by cytomegalovirus (CMV), herpes simplex virus, enteroviruses, parvovirus B19, hepatitis B and C viruses. Some viruses are not only infectious agents but also contribute to the development of malformations of various organs and systems. Currently, CMV is the most common cause of perinatal infection, detected in 1–2% of all newborns (3,5,6,7,8,9).

The main route of infection is hematogenous transplacental transmission, which occurs during a primary infection in the mother and concurrent placental damage impairing its barrier function. An ascending infection route is also possible – with CMV present in cervical and vaginal secretions or infected amniotic fluid. In 5–7% of cases, newborns are infected intranatally either through direct contact with infectious material or by aspiration of infected amniotic fluid containing CMV (10,11). In the postnatal period, 30% of newborns are infected through maternal secretions containing the virus – saliva, urine, genital discharge, breast milk, blood (11). Clinical manifestation of congenital CMV infection occurs in 10–15% of cases, with liver involvement in 40–63,3% of children (7,12,13,14). The likelihood of vertical transmission of herpes simplex virus (family Herpesviridae) ranges from 1:2,500 to 1:15,000 newborns. Neonatal herpes has a high mortality rate of 50–70% (8). Herpes simplex virus type 2 plays a dominant role in neonatal herpes and causes the disease in 70% of cases. Infection most often occurs intranatally (60–70%), though an ascending route is possible. Transplacental transmission of herpes simplex virus is rare and occurs during viremia in a pregnant woman due to primary infection. Liver damage in herpes infection is relatively common and occurs in both localized and generalized forms of the disease (3). Hepatitis B and C viruses also play an important role in the development of NH (15,16). Congenital hepatitis caused by these viruses is now rare due to various preventive measures.

Mechanisms of hepatocyte damage in infectious NH vary. Possible mechanisms include:

- Direct viral effect (e.g., in herpes infections) – viral cytolysis
- Indirect effect via the immune system (e.g., in hepatitis B) – immune cytolysis
- Combined mechanism (e.g., in hepatitis C) – viral-immune cytolysis

✉ ***Correspondence address:***
MUDr. Jakub Bízik
SLAPA ÚDZS Martin
Kuzmányho 27/B
036 01 Martin
jakub.bizik@udzs-sk.sk

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87. **Mascaux C, Angelova M, Vasaturo A, et al**. Immune evasion before tumour invasion in early lung squamous carcinogenesis. *Nature* 2019; 571(7766): 570–575.
88. **Giraldo NA, Nguyen P, Engle EL, et al**. Multidimensional, quantitative assessment of PD-1/PD-L1 expression in patients with Merkel cell carcinoma and association with response to pembrolizumab. *J Immunother Cancer* 2018; 6(1): 99.
89. **Dawe M, Shi W, Liu TY, et al**. Reliability and Variability of Ki-67 Digital Image Analysis Methods for Clinical Diagnostics in Breast Cancer. *Lab Invest* 2024; 104(5): 100341.
90. **Flotte TJ, Derauf SA, Byrd RK, et al**. Democratizing Artificial Intelligence in Anatomic Pathology. *Arch Pathol Lab Med* 2025; 149(1): 55–59.
91. **Yoder A, Inge LJ, Chen CC, et al**. Computer-aided scoring of erb-b2 receptor tyrosine kinase 2 (HER2) gene amplification status in breast cancer. *J Pathol Inform* 2022; 13: 100116.
92. **Bankhead P**. QuPath User Documentation. *Internet*. Dostupné z: https://qupath.readthedocs.io/en/stable/index.html. Přístup dne 28.4.2025.
93. **National Institutes of Health.** ImageJ. *Internet*. Dostupné z: https://imagej.net/imagej-wiki-static/Welcome. Přístup dne 28.4.2025.
94. **Rau A, Bodenmiller B**. HistoCAT. *Internet*. Dostupné z https://bodenmillergroup.github.io/histocat-web/#overview. Přístup dne 28.4.2025.
95. **Indica Labs**. HALO – Quantitative Image Analysis for Pathology. *Internet*. Dostupné z https://indicalab.com/halo/. Přístup dne 28.4.2025.
96. **Aiforia Technologies**. Aiforia: AI – for image analysis. *Internet*. Dostupné z https://www.aiforia.com/. Přístup dne 28.4.2025.
97. **Roche**. uPath Image Analysis Algorithms. *Internet*. Dostupné z https://diagnostics.roche.com/us/en/products/other/upath-image-analysis-algorithms.html. Přístup dne 28.4.2025.
98. **Singh V, Manu V, Malik A, et al**. Diagnostic utility of p63 and α-methyl acyl Co A racemase in resolving suspicious foci in prostatic needle biopsy and transurethral resection of prostate specimens. *J Cancer Res Ther* 2014; 10(3): 686–692. doi: 10.4103/0973-1482.138194.
99. **Trpkov K, Bartczak-McKay J, Yilmaz A**. Usefulness of cytokeratin 5/6 and AMACR applied as double sequential immunostains for diagnostic assessment of problematic prostate specimens. *Am J Clin Pathol* 2009; 132(2): 211–307.
100. **Obiorah IE, Wang HW, Ma D, et al**. The Effectiveness of Dual-Staining Immunohistochemistry in the Detection of Mantle Cell Lymphoma in the Bone Marrow. *Am J Clin Pathol* 2022; 157(5): 709-717.
101. **Taube JM, Roman K, Engle EL, et al**. Multi-institutional TSA-amplified Multiplexed Immunofluorescence Reproducibility Evaluation (MITRE) Study. *J Immunother Cancer* 2021; 9(7): e002197.
102. **Kimura A, Tsujikawa T, Morimoto H, et al**. Rapid multiplex immunohistochemistry for characterizing tumor-immune microenvironment. *Heliyon* 2024; 10(13): e33830.
103. **Státní ústav pro kontrolu léčiv (SÚKL).** Metodické doporučení pro implementaci požadavků IVDR na prostředky vyráběné a používané pouze v rámci zdravotnického zařízení. Praha, CZ: SÚKL; 2024: 1-46.