




# Bruising and Bleaching Cosmetics

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## Abstract

A review of the literature shows that bruises impair the aesthetic appearance of the skin. At the same time, official medicine has no cure for urgent skin discoloration in the area of bruises. Attention is drawn to the fact that alkaline hydrogen peroxide solutions effectively decolorize blemishes and the traces of blood by local interaction under in vitro and in vivo conditions. It has been shown that the main ingredients of these solutions are water, hydrogen peroxide, and sodium hydrogen carbonate. Some products have been developed for bleaching blood stains and marks on textiles, bandages, skin, nails, and inside the skin in the area of bruises. Here, the leading medical technologies for whitening cosmetic products are reviewed.

**Keywords:** Bleaching Cosmetics, Bruising, Hematoma, Hydrogen peroxide, Trauma

## 1. Context

A bruise is an inner area of the skin stained by blood spilling from blood vessels, commonly referred to as a black and blue spot (1). Since ancient times, bruises have been well known to humankind, as they are mentioned in sacred texts of all major religions (2). It is also known that a fresh bruise initially has a red color, and then it becomes successively blue, yellow, or green and disappears entirely in 5 - 8 days. Therefore, the color of the bruise can be used to determine how old it is (3-5). The skin in the bruised area is stained with blood because of the high content of red blood cells (6, 7), which have a red color due to a pigment protein, hemoglobin. However, the color of hemoglobin may change. For example, hemoglobin bound to oxygen is bright red, and hemoglobin bound to carbon dioxide takes on a dark cherry color (2). Hemoglobin color changes occur only in the living red blood cells.

When live red blood cells penetrate the skin and subcutaneous fatty tissue, the plasma surrounding these cells is absorbed into the blood. The red blood cells are deprived of this natural nutrient medium, leading to gradual death and rupture. Hemoglobin remains unchanged for some time, but once the red blood cells rupture, this protein is not protected anymore by the red blood cell membrane from other cells and enzymes. As a result, hemoglobin outside the erythrocytes is metabolized, converting sequentially into different metabolites that retain their pigments with colors from dark cherry to yellow. It is thought that bruises change color because residual blood in the skin

is gradually absorbed by the tissues or cleared by the immune system (3).

In cases where bruising is combined with traumatic injury and soft tissue inflammation, a trauma diagnosis is made, and anti-inflammatory and local anesthetic medications are used. When bruising is not accompanied by traumatic soft tissue injury, a medical diagnosis is not made, and no medications are prescribed. However, bruises create aesthetic problems on the face or other visible areas of the skin. Therefore, regardless of traumatic soft tissue injury, these bruises are temporarily resolved with cosmetic makeup applying powder and/or cream (2).

## 2. True Bruising as Aesthetic Problem

Bruises impair the aesthetic appearance of the skin, but not for long. No one doubts that any bruise will disappear on its own in an average of a week. However, in some cases, there is an urgent need to correct this aesthetic problem earlier than expected, and sometimes drastically. At the same time, there are no unique cosmetic products for this aim. Therefore, women usually use ordinary cosmetic powder and ordinary cosmetic creams (8). Staining the skin over the bruise with cosmetic dye temporarily restores the aesthetic appearance. Official medical science has not recognized bruising as an independent disease, and there is no official standard of care for bruising (2, 9, 10). Official cosmetology and dermatology offer no cures for the urgent discoloration of bruises (2, 9, 11).

It is different when a bruise is accompanied by pain. This occurs when bruises are caused by hitting a hard blunt object, trauma, and wounds (12). In such cases, mechanical trauma causes damage to the blood vessels, bleeding, skin staining, and bruise formation. Moreover, mechanical compression and damage to soft tissues located under the skin in the place of contusion occur, leading to the inflammation and soreness of the injured soft tissues. Therefore, anti-inflammatory drugs and/or local anesthetics may be used in these cases (13-15). However, many are still unaware that blood staining of the skin or bruising is entirely different and independent from traumatic damage to soft tissues accompanied by inflammation. Forensic medical examinations still rely on the classification of bruising, which unknowingly substitutes the classification of the danger of mechanical damage to the soft tissues for the health of victims (2, 9). Therefore, it is believed that anti-inflammatory agents and/or local cooling should be used to prevent and treat bruising (16).

It has been proven that sometimes bruises occur without soft tissue damage and are not inflamed. For example, bruises may be observed at the injection site (17, 18). Therefore, such bruises do not cause physical suffering. These results suggested that human blood, which changes the skin color in the bruised area, does not have a local irritant effect (19). True bruising, defined as skin staining with blood without traumatic injury to the skin or other soft tissues, is not a health hazard. Therefore, it is not considered a disease and does not require medication. However, bruises tarnish the color of the skin for several days and often cause aesthetic problems. To solve these aesthetic problems occurring with bruises on the face or other visible areas, people have to use their home remedies because the official pharmacy and pharmacology offers no medications, hygienic measures, or cosmetics for the urgent discoloration of bruises (20, 21). Ancient manuscripts on remedies also lack information on the discoloration of bruises (2).

### 3. Bruise with Traumatic Injury and Soft Tissue Inflammation

As mentioned, bruising may or may not be accompanied by traumatic injury and local soft tissue inflammation. When there is traumatic soft tissue injury, reactive inflammation develops in the skin in the area of injury, which may disappear or transform into true inflammation of varying severity depending on the intensity of the traumatic soft tissue injury. Therefore, inflammation may be reversible and/or irreversible. In any case, it usually involves not only the subcutaneous fatty tissue, muscles, and ligaments that have sustained a traumatic injury but also the skin in the area of the bruise, regardless of the presence

of mechanical damage. Therefore, hitting a solid blunt object causes local hyperemia, hyperthermia, swelling, and pain without bruising. The cause of inflammation symptoms in the skin bruise is not the blood soaked into the skin but inflammatory mediators appearing in the skin from damaged and inflamed soft tissues. Moreover, traumatic soft tissue injury can be of different severity. Mild injury causes local reactive inflammation of a reversible nature, which can disappear without a trace in a few minutes or hours. In severe soft tissue damage, the inflammation becomes irreversible, the damaged tissues die, and a scar is formed in their place. In this regard, local hyperthermia in the bruised area develops only when trauma causes damage and inflammation of the soft tissues. Such local temperature dynamics have been observed with a thermal imager in the skin of the back. For example, when a police baton hits the back or when the skin is pinched together with the subcutaneous soft tissues in a healthy adult volunteer (19).

A similar pattern was found when observing the local temperature dynamics in the area of post-injection bruises using thermal imaging. The rupture of a blood vessel with an injection needle and/or intradermal blood injection was found to cause a hematoma, but not local inflammation and local hyperthermia (18). At the same time, blood spilling from the blood vessels into the surrounding tissues, including the skin, has been found to be safe for these tissues.

The identified relationship between true bruising (without symptoms of local inflammation) and the local inflammation of the damaged tissues (with a symptom of local inflammation, including local hyperthermia) allowed us to develop a new differential diagnosis method. For this aim, infrared monitoring of local temperature dynamics utilizing a thermal imager was suggested. Studies have shown that infrared imaging provides the differential diagnosis of non-inflamed bruises (true bruises) and inflamed bruises (bruises combined with traumatic injury and soft tissue inflammation). The novelty of this method led to the development of two inventions: "Persons infrared differential express-diagnostics of bruising and injury of soft tissues" (patent RU No. 2577510) and "The infrared tomography of body surface for the forensic medical examination of living people" (patent RU No. 2581718).

### 4. Drug Solutions that Whiten the Skin in the Area of Bruises

The discovery of the basic "mystery" of bruises ensured the successful development of medications that rapidly decolorize the uninflamed bruises. The ability of medicines to bleach hemoglobin has been emphasized because hemoglobin and its color metabolites are the pri-

mary pigments in the bruised area (21). Today, a new group of medications has been discovered that urgently bleaches the skin and many other blood-soaked tissues. The discovery of these medicines closed a white hole in aesthetic pharmacology, hematology, dermatology, and cosmetology (2).

In real life, bruises always have aesthetic significance. Bruises on the visible parts of the body annoy people not by inflammation and pain but by worsening the aesthetic aspects because of discoloration in the skin area. As a result, in the case of non-inflamed bruises, people have long sought to improve the aesthetic results quickly. At the same time, all efforts aimed to restore the natural color of tissues in the bruised area. At the beginning of the 21st century, in order to develop new medicines capable of quickly discoloring the skin in the bruised area and immediately improving the aesthetic result in the presence of a non-inflamed bruise, known (and even "old") medications were used with new physical and chemical properties was chosen (22). Today, we can claim that the chosen direction has led to success.

When developing blood whitening preparations, research was devoted to studying mechanical, physical, chemical, and physicochemical factors of the local interaction of substances with tissues stained with blood, blood residues, erythrocytes, hemoglobin, and its colored metabolites. In classical pharmacology, modern cosmetology, dermatology, and hematology, insufficient attention has been paid to the physicochemical factors of the local interaction of hygiene products with blood portions. In particular, there have been no studies devoted to the possibility of bleaching hemoglobin and its colored metabolites by such physicochemical factors of local interaction as alkaline, osmotic, carbonation, and temperature activity (2, 21). In addition, even before the development of bruise bleaches, solvents for dense pus masses and sulfur plugs had been discovered. They were based on aqueous alkaline solutions of hydrogen peroxide (23). However, the possibility of the urgent bleaching of bruises and hematomas using alkaline hydrogen peroxide solutions remained unknown (24, 25).

Several agents were developed and invented, giving rise to a new group of cosmetic preparations known as bruise bleaching agents (26). Preparations of this group have the following differences from all known medications. First, they are all aqueous solutions of hydrogen peroxide and sodium bicarbonate. Consequently, all the ingredients of these remedies are known, safe, and edible. Secondly, bruise bleach solutions are weakly alkaline, osmotic, hyperthermic, and have oxygen-forming activity (21). The mechanism of action of bruise-bleaching agents is causing alkaline saponification, oxygen oxidation, and the discoloration of stained proteins and protein-lipid com-

plexes, in particular plasma, blood cells, hemoglobin, and its colored metabolites. Moreover, local saponification is induced by sodium bicarbonate, while oxygen oxidation and the decolorization of hemoglobin pigment and its colored metabolites are provided by hydrogen peroxide (27). Sodium bicarbonate is an effective alkaline buffer, and hydrogen peroxide is an "accumulator" of oxygen released from a bound state by the blood catalase enzyme (28).

It is noteworthy that sodium bicarbonate and hydrogen peroxide have long been widely, successfully, and safely used in medical institutions. Specifically, a 4% solution of sodium bicarbonate is utilized for intravenous injections. A 3% hydrogen peroxide solution is sold over-the-counter in pharmacies as an antiseptic. A 5% hydrogen peroxide solution is used for hair whitening, and a 6.5% carbamide peroxide solution is applied as an over-the-counter remedy for earwax softening. In addition, a 5% - 20% solution of carbamide peroxide is used in dentistry to whiten teeth (2).

The results showed that hydrogen peroxide solution at  $\text{pH} < 7$  (i.e., hydrogen peroxide solution without alkali) and sodium bicarbonate solution without hydrogen peroxide does not provide emergency dissolution and decolorization of hemoglobin, blood, bruises, and hematomas. Only an alkaline hydrogen peroxide solution consisting of hydrogen peroxide, sodium bicarbonate, and water in specific ratios could urgently, effectively, and safely dissolve and decolorize blood spots, bumps, blood clots, bruises, hematomas, hemoglobin, and its metabolites. Screening and numerous laboratory and experimental studies were performed, including piglets and the isolated sections of pig skin. The obtained results allowed identifying the optimal ratios of these ingredients, after which they formed the basis for many cosmetics, hygiene products, and technologies for medical and domestic use. The results of laboratory and experimental studies were confirmed by research on healthy adult volunteers. Hydrogen peroxide and sodium bicarbonate solution have been shown to bleach the skin in the bruised area and discolor the blood inside the hematoma on the skin and under the nail. In addition, alkaline hydrogen peroxide solution has been found to be a suitable solvent for dried blood. It bleaches bloodstains on the body surfaces, cotton-gauze bandages, swabs, clothing, medical instruments, teeth, dentures, and various household products.

The discovered biological activity of the alkaline solutions of hydrogen peroxide and the found "necessary" ("right") ratios of ingredients formed the basis of the following inventions: (1) "bruise bleacher" (RU Patent No. 2539380); (2) "bleaching agent" (RU Patent No. 2589682); (3) "method for skin discoloration in the bruising area" (RU Patent No. 2586278); (4) "agent for intradermal bruise whitening" (RU Patent No. 2573382); (5) "method for skin

discoloration in the bruising area" (RU Patent No. 2582215); (6) "bleaching opener of dried blood for wrapping bandages adhered to a wound" (RU Patent No. 2653465); (7) "method of emergency bleaching and blood crust removal from the skin in place of squeezed out acne" (RU Patent No. 2631593); (8) "method for whitening of sore under nail" (RU Patent No. 2631592); (9) "method for blue nail treatment" (RU Patent No. 2641386); (10) "decolorant of blood" (RU Patent No. 2647371); (11) "method for the whitening of a bruise under eye" (RU Patent No. 2639283); (12) "means for intravital skin whitening near blue eyes" (RU Patent No. 2639485); (13) "method of the emergency bleaching of skin hematoma under eye" (RU Patent No. 2679334).

Furthermore, it should be pointed out that in addition to whitening agents, the "Method for bruise bleachers screening" was developed and patented (RU Patent No. 2634268). The bleaching activity of the latter medications was evaluated in an isolated viable section of the anterior abdominal wall of the pig with artificially created hematomas. Artificial bruises on this isolated area were proposed to be created in laboratory conditions by the intradermal injections of pig blood.

## 5. Bleaching Cosmetics and Application Options

Two types of methods and means of bleaching underlie the inventions mentioned above. One of these inventions provides the possibility of urgent skin bleaching in the bruised area. Such a rapid result is possible by injecting an isotonic solution of 0.9% sodium chloride or an isotonic solution of a bleaching agent containing 0.01% - 0.03% hydrogen peroxide and 1.8% sodium hydrogen carbonate into the skin in the bruised area (RU Patent No. 2573382, RU Patent No. 2586278). For the urgent bleaching of the bruise, the selected solution is used by several intradermal injections. Some of the solutions are injected into the skin and can completely infiltrate the skin over the entire area of the bruise, creating a "lemon crust" effect in the skin. As a result, the intensity of the skin color in the bruised area reduces instantly due to the dilution of blood and hemoglobin residues by the injected liquid. When an alkaline hydrogen peroxide solution is injected, the splitting of hydrogen peroxide into water and oxygen by catalase enzyme, which is always present in blood and its residues, begins. The released oxygen oxidizes the pigments and discolors them. A correctly chosen concentration of hydrogen peroxide rules out gas embolism.

Moreover, whitening cosmetics allow foregoing injections and apply an alkaline hydrogen peroxide solution in the skin. The bleaching effect will slowly develop, taking several minutes and sometimes hours or days. However, it is easier to perform and safer for the patient. A bleach solution containing 0.03% - 3% hydrogen peroxide and 1.8% -

10% sodium hydrogen carbonate is used. The selected solution is heated to 42°C - 45°C, and a cotton-gauze tampon is dampened in the warm solution and applied to the skin in the bruised area as a warm lotion. Afterwards, the tampon is covered with transparent and colorless polyethylene film, and a hot-water bottle at 42° - 45° is applied for 10 min (RU Patent No. 2639283, RU Patent No. 2639485). The procedure is repeated if the bruise is not effectively bleached.

## 6. Conclusions

We reviewed the first successful results achieved in developing alkaline hydrogen peroxide solutions designed for the emergency decolorization of blood traces both on and inside the skin surface with a single local application. Based on the available literature and invention patents, alkaline hydrogen peroxide solutions can be cosmetically and/or hygienically bleaching agents and require more detailed studies. The use of hydrogen peroxide solution for skin discoloration was first reported for ecchymosis (29). Studies were continued under laboratory conditions for bloodstains, under experimental conditions for artificial bruises in the skin of pigs, and finally for bruises in the healthy adult volunteers (19). The results indicated the ability of alkaline hydrogen peroxide solution, when applied topically, to rapidly, effectively, and safely bleach bloodstains and skin in the area of bruises.

Volunteer studies were conducted using a thermal imaging camera. Infrared monitoring of local body surface temperature dynamics in bruise sites occurring with or without traumatic soft tissue injury proved that blood in the area of bruises has no local irritant and inflammatory effects. In particular, it was shown that the skin in the bruised area following intradermal blood injection had the same temperature as the surrounding skin areas. Therefore, it could be concluded that skin is not inflamed in the area of a true bruise (19). The above results help understand why bruises are still not classified as a disease.

In addition, there have been reports on the ability of hydrogen peroxide to increase the local temperature in the blood and isolated erythrocytes when interacting with them locally (30, 31). The present review listed inventions that allow skin discoloration in the area of bruises and hematomas. They are all based on the local application of warm alkaline hydrogen peroxide solutions. In addition, two technologies of applying alkaline hydrogen peroxide solutions to bleach the skin in the area of bruises are indicated, namely intradermal injections and cutaneous applications. We hope that this review will contribute to the development of cosmetic and/or hygienic products and technologies for effective and safe skin decolorization in the

area of bruises to improve the aesthetic outcome and psychological well-being of the patients.

## Footnotes

**Authors' Contribution:** A. U. and N. U. contributed to the conception and design of the study; material preparation and data collection were performed by all authors; A. Sh. and E. F. performed data collection, analysis and interpretation; A. U. and N. U. wrote the first draft of the manuscript; all authors edited the final manuscript.

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## References

- Jaliman D. *Bruises*. New York City, New York, USA: WebMD; 2021, [updated November 15, 2021; cited 2022 Jan 16]. Available from: <https://www.webmd.com/skin-problems-and-treatments/guide/bruises-article>.
- Urakov AL. Medications and bruises: past, present, and future. *Reviews on Clinical Pharmacology and Drug Therapy*. 2020;**18**(2):161-70. doi: 10.17816/rcf182161-170.
- Scaffide KR, Sheridan DJ, Campbell J, Deleon VB, Hayat MJ. Evaluating change in bruise colorimetry and the effect of subject characteristics over time. *Forensic Sci Med Pathol*. 2013;**9**(3):367-76. doi: 10.1007/s12024-013-9452-4. [PubMed: 23839662].
- Scaffide KN, Downing NR, Downing NR, Hayat MJ. Detection of Inflicted Bruises by Alternate Light: Results of a Randomized Controlled Trial. *J Forensic Sci*. 2020;**65**(4):1191-8. doi: 10.1111/1556-4029.14294. [PubMed: 32012284]. [PubMed Central: PMC7383750].
- Scaffide KN, Downing NR, Kutahyaloglu NS, Sebeh Y, Sheridan DJ, Hayat MJ. Quantifying the Degree of Bruise Visibility Observed Under White Light and an Alternate Light Source. *J Forensic Nurs*. 2021;**17**(1):24-33. doi: 10.1097/JFN.0000000000000304. [PubMed: 33278184].
- Mairbaurl H. Red blood cell function in hypoxia at altitude and exercise. *Int J Sports Med*. 1994;**15**(2):51-63. doi: 10.1055/s-2007-1021020. [PubMed: 8157369].
- Mairbaurl H. Red blood cells in sports: effects of exercise and training on oxygen supply by red blood cells. *Front Physiol*. 2013;**4**:332. doi: 10.3389/fphys.2013.00332. [PubMed: 24273518]. [PubMed Central: PMC3824146].
- Townsend DC. *How to Use Stage Makeup to Create Bruises and Cuts*. Oxfordshire, England, UK: Routledge; 2020, [updated May 1, 2020]. Available from: <https://www.routledge.com/blog/article/how-to-use-stage-makeup-to-create-bruises-and-cuts#>.
- Urakov A. What are bruises? Causes, Symptoms, Diagnosis, Treatment, Remedies. *Int J Compr Adv Pharmacol*. 2020;**5**(1):1-5. doi: 10.18231/j.ijcaap.2020.001.
- Davis CP. *Bruises (Contusions): Causes, Colors, and How to Heal Them*. San Clemente, California, USA: OnHealth; 2021, [updated 11/10/2021; cited 2022 Jan 17]. Available from: <https://www.onhealth.com/content/1/bruises-causes-treatments-colors>.
- Behrang E, Goodarzi A, Roohaninasab M, Sadeghzadeh-Bazargan A, Najar Nobari N, Ghassemi M. A Review of Scar Treatment Related to Acne and Burn. *Journal of critical reviews*. 2020;**7**(4). doi: 10.31838/jcr.07.04.133.
- Terazawa K. [Observations on injuries by blunt objects]. *Nihon Hoigaku Zasshi*. 2010;**64**(2):103-20. Japanese. [PubMed: 21351412].
- Cassuto J, Sinclair R, Bonderovic M. Anti-inflammatory properties of local anesthetics and their present and potential clinical implications. *Acta Anaesthesiol Scand*. 2006;**50**(3):265-82. doi: 10.1111/j.1399-6576.2006.00936.x. [PubMed: 16480459].
- Goodarzi A, Behrang E, Ghassemi M, Najar Nobari N, Sadeghzadeh-Bazargan A, Roohaninasab M. Acne scar; a review of classification and treatment. *J Crit Rev*. 2020;**7**(5):815-23.
- Mohammady M, Sadeghi N. Effect of Cold Application on Bruising and Pain Following Heparin Subcutaneous Injection: A Systematic Review and Meta-Analysis. *J Nurs Scholarsh*. 2020;**52**(6):634-42. doi: 10.1111/jnu.12598. [PubMed: 32886867].
- Jueakaew S, Piancharoenin R, Pinkesorn N, Thipayarom S, Sermasathanasawadi N. Novel subcutaneous low-molecular-weight heparin injection technique to reduce post-injection bruising. *Phlebology*. 2019;**34**(6):399-405. doi: 10.1177/0268355518813512. [PubMed: 30453827].
- Li Y, Dong S, Wang P, Sun J, Jiang H, Liu F. Influence of low-molecular-weight heparin injection sites on local bruising and pain: A systematic review and meta-analysis. *J Clin Pharm Ther*. 2021;**46**(3):688-97. doi: 10.1111/jcpt.13323. [PubMed: 33325109].
- Urakov AL, Urakova NA, Chernova LV, Fisher EL, Ammer K. [Infrared thermography can discriminate the cause of skin discolourations]. *Thermol. Int*. 2015;**25**(4):209-15. Russian.
- United States Pharmacopeial Convention. *The United States Pharmacopeia 2013: USP 36 ; The National Formulary : NF 31*. Rockville, MD, United States; 2012.
- Urakov A, Urakova N, Nikolenko V, Belkharoeva R, Achkasov E, Kochurova E, et al. Current and emerging methods for treatment of hemoglobin related cutaneous discoloration: A literature review. *Heliyon*. 2021;**7**(1). e05954. doi: 10.1016/j.heliyon.2021.e05954. [PubMed: 33506129]. [PubMed Central: PMC7814147].
- Seirafianpour F, Sodagar S, Mozafarpour S, Baradaran HR, Panahi P, Hassanlouei B, et al. Systematic review of single and combined treatments for different types of striae: a comparison of striae treatments. *J Eur Acad Dermatol Venereol*. 2021;**35**(11):2185-98. doi: 10.1111/jdv.17374. [PubMed: 34021922].
- Urakov AL. The change of physical-chemical factors of the local interaction with the human body as the basis for the creation of materials with new properties. *Epitoanyag - Journal of Silicate Based and Composite Materials*. 2015;**67**(1):2-6. doi: 10.14382/epitoanyag-jsbcm.2015.1.
- Urakov A, Urakova N, Reshetnikov A. Oxygen Alkaline Dental's Cleaners from Tooth Plaque, Food Debris, Stains of Blood, and Pus: A Narrative Review of the History of Inventions. *J Int Soc Prev Community Dent*. 2019;**9**(5):427-33. doi: 10.4103/jispcd.JISPCD\_296\_19. [PubMed: 31620374]. [PubMed Central: PMC6792311].
- Seirafianpour F, Pour Mohammad A, Moradi Y, Dehghanbanadaki H, Panahi P, Goodarzi A, et al. Systematic review and meta-analysis of randomized clinical trials comparing efficacy, safety, and satisfaction between ablative and non-ablative lasers in facial and hand rejuvenation/resurfacing. *Lasers Med Sci*. 2022. doi: 10.1007/s10103-022-03516-0. [PubMed: 35107665].
- Mehran G, Fotooei M, Goodarzi A, Farokh Forghani S, Rohaninasab M, Ghassemi M, et al. Comparison of the therapeutic effect of microneedling with carbon dioxide laser in hypertrophic burn scars: a randomized clinical trial. *Iran. J. Dermatology*. 2019;**22**(2):53-7.

26. Urakov A. New medicines: the bleachers of bruises, blue nails, hematomas, blood stains and bloody crusts. *Australas. Med. J. (Online)*. 2017;**10**(11):942-3.
27. Urakov AL, Urakova NA. [Hydrogen peroxide discolors blood in the cavity of the hematoma under the nail and in the skin over the bruise]. *Regional blood circulation and microcirculation*. 2020;**19**(2):67-74. Russian. doi: [10.24884/1682-6655-2020-19-2-67-74](https://doi.org/10.24884/1682-6655-2020-19-2-67-74).
28. Thomas EL, Milligan TW, Joyner RE, Jefferson MM. Antibacterial activity of hydrogen peroxide and the lactoperoxidase-hydrogen peroxide-thiocyanate system against oral streptococci. *Infect Immun*. 1994;**62**(2):529-35. doi: [10.1128/iai.62.2.529-535.1994](https://doi.org/10.1128/iai.62.2.529-535.1994). [PubMed: [8300211](https://pubmed.ncbi.nlm.nih.gov/1300211/)]. [PubMed Central: [PMC186138](https://pubmed.ncbi.nlm.nih.gov/PMC186138/)].
29. Molenda MA, Sroa N, Campbell SM, Bechtel MA, Mitch Opremcak E. Peroxide as a novel treatment for ecchymoses. *J Clin Aesthet Dermatol*. 2010;**3**(11):36-8. [PubMed: [21103315](https://pubmed.ncbi.nlm.nih.gov/21103315/)]. [PubMed Central: [PMC2989814](https://pubmed.ncbi.nlm.nih.gov/PMC2989814/)].
30. Urakov AL, Stolyarenko AP, Kopitov MV, Bashirov LI. [Dynamics of the local temperature of blood, pus, mucus and catalase solution when they interact with a solution of hydrogen peroxide in vitro]. *Thermol. Int*. 2021;**31**(3):150-2. Russian.
31. Kasatkin A, Urakov A. Effect of hydrogen peroxide on erythrocyte temperature in vitro. *Chem Biol Interact*. 2022;**354**:109837. doi: [10.1016/j.cbi.2022.109837](https://doi.org/10.1016/j.cbi.2022.109837). [PubMed: [35104488](https://pubmed.ncbi.nlm.nih.gov/35104488/)].