



Alkaline Hydrogen Peroxide Solution is an Expectorant, Pyolytic, Mucolytic, Hemolytic, and Bleaching Drug for Treating Purulent Diseases, Hematomas and Bruising

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

It has been established that warm alkaline solutions of hydrogen peroxide with local interaction with thick pus, mucus, sputum and blood have local pyolytic, mucolytic and hemolytic effects. It was found that the dissolving effect is associated with the alkaline properties of the drug, which are provided by sodium bicarbonate. Sodium bicarbonate provides the process of alkaline saponification of proteins and protein-lipid complexes. It is shown that hydrogen peroxide intensively decomposes into water and oxygen gas under the action of the catalase enzyme. In turn, catalase is always present in blood, mucus, sputum, pus, fibrous and serous fluid. At the same time, the released oxygen forms gas bubbles that literally tear apart biological masses during cold boiling and turn them into fluffy white foam. At the same time, the appearance of oxygen in an alkaline environment ensures the process of discoloration of biological pigments, such as hemoglobin and its color metabolites. The indicated pharmacological effect of a warm alkaline solution of hydrogen peroxide at local interaction is proposed to be used for the treatment of

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purulent diseases, thrombosis, bruising and hematomas. The technologies of using the drug for urgent restoration of breathing in obstructive purulent bronchitis, for urgent discoloration of the skin and nail plate with bruising and hematoma, as well as for urgent and safe peeling of a bloody bandage from a wound are listed.

Keywords: Hydrogen peroxide; bleaching cosmetics; hemolytic; pyolytic; expectorant.

1. INTRODUCTION

Until recently, it was believed that hydrogen peroxide is an antiseptic [1,2]. Hydrogen peroxide has long been used as a recognized, safe and affordable disinfectant for surfaces, cuts, scratches, burns and minor wounds, as well as for mouthwash, which helps relieve ulcers, gingivitis and reduce mucus secretion [2-6]. As prescription drugs became increasingly popular, interest in the benefits of hydrogen peroxide declined in the 1940s. However, recently there has been increased attention to hydrogen peroxide [1,2,7]. The mechanism of action of hydrogen peroxide has long attracted researchers, and many aspects of the action of this drug have been thoroughly studied [8-10]. However, the mechanism of action, taking into account the physicochemical properties and factors of local interaction, has not been fully studied [11,12]. In recent years, it has been established that among the physico-chemical factors of local drug interaction, the most important are local temperature, acidity (alkalinity) and gas content (carbonation) [13-15]. Other things being equal, other physical-chemical factors of local interaction are less important for the local action of drugs.

It has been shown that modern drugs, including hydrogen peroxide, are substances, each of which in real conditions can be in solid, liquid and gaseous aggregate states [16-18]. Therefore, any drug, in addition to its specific pharmacological activity, always has non-specific biological activity, which additionally occurs in the drug due to different mechanical, physical, chemical and physical-chemical properties of different aggregation states (tablets, solutions, aerosols) [2,7,13]. In particular, solutions have a certain volume, specific gravity, gas composition, colloidal properties, acid (alkaline) activity, osmotic activity and temperature [13,14,15]. It is shown that currently drugs are considered qualitative if they have certain mechanical and physical-chemical properties, taken as a standard of quality. At the same time, the Pharmacopoeia states that the same

substances, but with different physical-chemical properties, are substandard substances that should be discarded [19].

Despite this, it has been proven that changing the physico-chemical properties of drugs does not deprive them of biological activity [7,20]. Moreover, it has been shown that the physico-chemical properties of drugs ensure their urgent local action when applied locally. Therefore, it was proposed to purposefully change the physico-chemical properties of "old" medicines to create "new" medicines with a new mechanism of local action [21-23]. It has been shown that drugs have minimal nonspecific local action when the physical-chemical activity of drugs corresponds to the normal (physiological) values of the tissues with which the drug interacts. If this activity of drugs differs from the physiological norm in one direction or another, the nonspecific local effect of drugs increases the more the physical-chemical properties of drugs deviate from the corresponding properties of tissues. It is reported that with an increase in the difference between the physical-chemical activity of drugs and the physico-chemical activity of the tissue with which the drug interacts, the following pharmacological effects consistently develop when applied topically: local irritant effect, denaturing effect and, finally, cauterizing effect [24]. The first report that a change in the acid (alkaline), osmotic, temperature and gas activity of drug solutions allows changing their pharmacological activity, especially when local used, appeared in 2007 in Russia [25]. However, the dependence of the local action of hydrogen peroxide solutions on temperature, acid (alkaline) and osmotic activity remains insufficiently studied.

2. THE SOURCES OF THE PROBLEM

The study of the role of physico-chemical properties of hydrogen peroxide solutions in their local action began with the process of cold boiling in the presence of the enzyme catalase. It was reported that the dissolution of carbon dioxide (CO₂) at an excess pressure of 0.2 ATM in an isotonic solution of 0.9% sodium chloride

turns this solution into a cold boiling solution under normal atmospheric pressure. This allows the solution to form carbon dioxide bubbles inside itself, the presence of which makes the solution "visible" for ultrasound in a closed cavity. Therefore, such a solution with intraperitoneal administration provides ultrasound visualization of the process of fluid movement inside the abdominal cavity. This increases the efficiency of washing the abdominal cavity with purulent peritonitis. Therefore, it was proposed to use the hypergasated solution as an original ultrasound contrast agent that improves abdominal flushing in purulent peritonitis by improving visualization of the movement of a portion of water inside the abdominal cavity [24,25]. After that, it was shown that the addition of 0.01-3% hydrogen peroxide to the solution increases the intensity of cold boiling of water when interacting with purulent masses or with traces of blood. The fact is that the enzyme catalase is always present in the blood and in purulent masses and under the action of catalase, hydrogen peroxide decomposes into water and oxygen gas. Therefore, the additional introduction of hydrogen peroxide into antiseptic solutions makes it possible to turn them into medicines that quickly dissolve, loosen and discolor thick pus, sulfur plugs, blood clots and spots, as well as skin and nail plates in the area of bruises and hematomas [25,26].

In 2015, the above ideas formed the basis of a new scientific direction in materials science, which was called "physico-chemical materials science" [13]. In subsequent years, in the field of pharmacy, the main research was carried out with solutions of hydrogen peroxide (H_2O_2). As a result, it was shown that a purposeful change in the physicochemical properties of the hydrogen peroxide solution expands the mechanism of local action of the drug and allows it to be used as a pyolytic, mucolytic, expectorant, hemolytic and bleaching medication. The fact is that the introduction of such a solution into the blood, pus, mucus, sputum, serous, fibrous fluid or into caseous masses immediately "triggers" a violent biochemical reaction of splitting hydrogen peroxide into water and oxygen gas. This process occurs under the action of the enzyme catalase, which is always present in these biological tissues. At the same time, the interaction medium foams and loosens, turning into an elastic foam of white color. Such a process of gas bubble formation has been known for a long time and is referred to as "cold boiling" [2,7,20,21,25].

In addition, it was found possible to repeatedly enhance the political activity of an alkaline solution of hydrogen peroxide by enriching it with oxygen gas or other gases under excessive pressure [20,25]. The fact is that the presence of an excess of gas in a solution of hydrogen peroxide enhances its ability to form the process of "cold boiling" to such an extent that such a carbonated medicine can not just dissolve, but literally "tear" thick biological masses and even sulfur plugs [21,26]. It is reported that a solution of 3% hydrogen peroxide, 10% sodium bicarbonate, heated to a temperature of +37 ° C, containing gases (carbon dioxide, oxygen or inert gases such as helium) under an excess pressure of 0.2 - 4.0 ATM is capable of almost instantly turning thick purulent masses and sulfur plugs into a white and very soft oxygen foam of white color [2,20,21]. It is shown that warm alkaline solutions of hydrogen peroxide have a sanitizing, geyser-like, deodorizing and pyolytic effect when irrigating various purulent wounds [27].

It is reported that an alkaline solution of hydrogen peroxide can be used in the form of irrigation not only for the sanitation of purulent wounds, but also for the sanitation and hygiene of the oral cavity in normal and in diseases. This is possible because an alkaline solution of hydrogen peroxide is a safe antiseptic and simultaneously dissolves, foams and whitens plaque [7]. In addition, it has been shown that inhalations and intrapulmonary injections of an alkaline solution of hydrogen peroxide can be used to sanitize and recanalize the respiratory tract when sputum, mucus, pus, fibrous and serous fluid accumulate in them. The fact is that local pyolytic, mucolytic, expectorant and recanalization effects are manifested in purulent laryngitis, tracheitis and bronchitis caused by bacterial infection, as well as in purulent obstructive bronchitis, severe bronchial asthma, bronchiectatic disease, cystic fibrosis, helminthic lung damage, tuberculosis lung damage, various superinfections of the lungs (including fungal pneumonia), complicating atypical pneumonia in COVID-19 [28-31].

It has been shown that traditional mucolytics and expectorant drugs, as well as generally accepted technologies for their use when filling the respiratory tract with mucus, sputum, pus and/or blood, do not provide urgent recanalization of the respiratory tract and urgent intrapulmonary oxygenation of blood [32-39]. In this regard, traditional expectorants and mucolytics are not included in the medical standard of emergency medical care for severe hypoxia caused by

respiratory obstruction. They are also not used in ARDS caused by a new coronavirus infection [16]. At the same time, it is reported that an alkaline solution of hydrogen peroxide, when applied topically, urgently dissolves not only pus, blood, but also thick sputum and mucus and urgently turns them into oxygen foam [30,31,40]. It is reported that aerosol inhalations and intrapulmonary injections of an alkaline solution of hydrogen peroxide confirm its immediate mucolytic, pyolytic, expectorant and oxygenating effects [30,41]. In this regard, aerosol inhalations and intrapulmonary injections of an alkaline solution of hydrogen peroxide have been proposed to increase intrapulmonary blood oxygenation in severe hypoxia caused by blockage of the respiratory tract by mucus, sputum and/or pus. The fact is that in this case, an alkaline solution of hydrogen peroxide turns these colloidal liquids into oxygen foam, which increases the absorption of oxygen into the blood both in the absence of breathing, and with natural breathing and artificial mechanical ventilation of the lungs. It is also reported that the intrapulmonary use of an alkaline solution of hydrogen peroxide can become an alternative to ECMO for an urgent increase in blood oxygenation in severe hypoxia caused by COVID-19 [30,41].

In parallel with this, it was shown that a warm solution of 3% hydrogen peroxide 10% sodium bicarbonate, when applied topically, provides urgent dissolution of blood clots, crusts and blood stains, as well as the peeling of bloody bandages from the surface of wounds [11,12]. It is reported that the hemolytic, washing, bleaching and deodorizing effect of this solution provides urgent discoloration and removal of fresh and old blood stains from clothing, bloody bandages, cotton gauze bandages, surgical gloves, medical instruments, hair, skin and mucous membranes in places of injuries, bruises, abrasions and surgical incisions [42,43]. Moreover, *in vitro* studies have found that an alkaline solution of hydrogen peroxide, when applied topically, immediately turns spots and blood clots into a white oxygen foam, which is accompanied by heat release [31,44].

In addition, it has been shown that an alkaline solution of hydrogen peroxide can be used for cosmetic discoloration of the skin in the area of bruises and nail plates in the area of subcutaneous hematomas. In particular, to discolor nails with a hematoma, a solution of 3% hydrogen peroxide and 10% sodium bicarbonate

must first be injected into the hematoma cavity in a volume that provides tissue discoloration, and then this solution must be applied externally with a compress. If urgent discoloration of the bruise is necessary, a very little concentrated alkaline solution of hydrogen peroxide should be used, which should be administered as intradermal injections. Injections should be made inside the skin until the lemon peel effect is formed on the entire area of the bruise. It is reported that for injectable discoloration of a bruise, a solution of 0.01 – 0.03% hydrogen peroxide and 1.8% sodium bicarbonate should be used [11,12,42,43].

In recent years, it has been shown that the pyolytic, hemolytic and bleaching activity of alkaline solutions of hydrogen peroxide allows them to be used as universal cleaning (bleaching) hygienic and cosmetic products not only in dermatology, cosmetology and dentistry, but also in domestic conditions. It is reported that alkaline solutions of hydrogen peroxide are highly effective and safe when washing and cleaning kitchen ceramic, glassware and other similar products that may be stained with traces and stains of biological origin containing the enzyme catalase [7,26,45]. In this regard, alkaline solutions of hydrogen peroxide have received another name - "oxygen-forming cleaning agents".

3. DISCUSSION

The appearance in certain parts of the body of a large number of purulent masses, sputum, mucus, blood, plasma, serous fluid, fibrous fluid and other biological colloidal fluids can become a serious problem in the treatment of many diseases: purulent wounds, purulent peritonitis, purulent pleurisy, abscesses, bronchiectasis, injuries, hematomas, bruises and others. This often requires hospitalization, surgical treatment and prolonged sanitation with solutions, including hydrogen peroxide solutions.

For many decades, the formulation of hydrogen peroxide solutions and the technology of their local application in the irrigation of purulent wounds did not undergo significant changes. However, at the beginning of the 21st century the foundations of physico-chemical material science were laid, which were applied in the field of pharmacy for modernization of "old" drugs. The results showed that targeted modification of some physicochemical properties of hydrogen peroxide solutions could indeed very significantly

increase the effectiveness of their topical application. In this regard, the generally accepted formulation of hydrogen peroxide solutions, the technology of their medical use in the treatment of "purulent" diseases were reviewed and the possibility of expanding the list of indications for use was studied.

It turned out that hydrogen peroxide solutions were traditionally considered as antiseptics and were used mainly in the treatment of purulent wounds, since the potential that can be identified by combining hydrogen peroxide with sodium bicarbonate, increasing the gas content at overpressure and heating the solution to +37 - +45°C, previously were not taken into account. It was shown that the combination of hydrogen peroxide with sodium hydrogen carbonate, increased oxygen gas content under increased pressure and heating allow to enhance the efficiency of local action of alkaline hydrogen peroxide solution on thick and sticky biological masses containing the enzyme catalase, as well as to give new biological activity and expand the list of indications for its application. It has been shown that moderate alkaline activity provides the hydrogen peroxide solution with alkaline saponification of proteins and protein-lipid complexes. Such physico-chemical activity with topical application explains the pyolytic, mucolytic, expectorant and hemolytic effects. It is reported that hydrogen peroxide provides the release of gaseous oxygen in the presence of the enzyme catalase, which explains the "explosive" effect on dense biological tissues, the geyser-like effect, their urgent transformation into fluffy white foam, disinfecting, deodorizing, antiseptic, bleaching effect and the ability to oxygenate blood by inhalation of an aerosol or intrapulmonary injection of an alkaline solution of hydrogen peroxide.

Therefore, warm alkaline hydrogen peroxide solutions can be indicated not only for treating purulent wounds and washing purulent cavities, but also for dissolving blood clots, bleaching blood stains on clothing and on human and animal body surfaces, for whitening skin and nail plates in the area of bruises and hematomas. In addition, the ability of warm alkaline hydrogen peroxide solution to turn mucus, sputum, pus and blood into oxygen foam can be used for urgent airway recanalization and increasing pulmonary blood oxygenation during hypoxia caused by respiratory obstruction by these biological colloidal fluids in COVID-19. Aerosol inhalation and intrapulmonary injections of alkaline hydrogen peroxide solution have been shown to

increase blood oxygenation and can therefore be recommended for emergency management of severe hypoxia in ARDS as an alternative to ECMO.

4. CONCLUSION

Thus, warm alkaline hydrogen peroxide solution when applied topically can have not only specific pharmacological effect, which provides antiseptic effect, but also non-specific (physical and chemical) effect, on purulent masses, mucus, sputum, blood and other biological tissues containing catalase enzyme. When applied topically, the physicochemical properties of alkaline hydrogen peroxide solution can provide the following effects: the ability to rapidly and effectively dissolve thick pus masses, thick mucus, sputum, sulfur plugs, dental plaque, blood clots and stains; the ability to rapidly bleach hemoglobin and its colored metabolites; the ability to urgently release oxygen gas, oxidize organic substances with heat release, increase blood oxygenation and eliminate hypoxia. The fact is that moderate alkaline activity of hydrogen peroxide solution creates optimal conditions for alkaline saponification of proteins and protein-lipid complexes, which underlies the pyolytic, mucolytic, expectorant and hemolytic action. The presence of hydrogen peroxide provides the release of oxygen gas in the presence of the enzyme catalase, which explains the "explosive", geyser-like effect on dense biological masses and thick colloidal fluids and their urgent transformation into fluffy oxygen foam, which underlies the antiseptic, disinfecting, deodorizing, detergent and bleaching action.

Creation of conditions for manifestation of nonspecific physico-chemical activity of warm alkaline hydrogen peroxide solution in its local application optimizes the treatment of various purulent diseases and expands indications for prescribing the drug. In particular, warm alkaline hydrogen peroxide solution can be administered as a pyolytic agent with the purpose of urgent dissolution and removal of thick and sticky pus masses, as a mucolytic and expectorant agent with the purpose of urgent dissolution and removal of thick mucus and sputum and restoration of airiness of airways, as a hemolytic agent for urgent dissolution of blood clots and restoration of patency of vascular catheters and blood vessels, and as a bleaching agent for urgent bleaching of teeth and bruises and as a detergent and cleaner for whitening medical and household products.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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