

در این مقاله می خوانیم:

پتانسیل استفاده از کربوکسی تراپی در بیماری های سیستم ادراری تناسلی

امروزه کربوکسی تراپی یک روش کاربردی و رایج می باشد. این روش ۷۰ سال است که در درمان وارد شده و ۵۰ سال است که در زمینه زیبایی کاربردی شده است. استفاده از این روش در درمان بیماران دارای مشکلات ادراری تناسلی نشان دهنده بهبود عملکرد، کاهش درد و التهاب و بهبود شرایط جسمانی روانی می شود که در نهایت موجب بهبود کیفیت زندگی بیماران می شود. لذا کربوکسی تراپی می تواند به عنوان یک درمان کاربردی در درمان بیماری های ادراری تناسلی بکار گرفته شود.

در این مقاله به بررسی ویژگی های درمانی کربوکسی تراپی اعم از افزایش رگزایی و گردش خون در محل مورد نظر، بهبود فعالیت و کیفیت بافت مورد نظر با افزایش اکسیژن رسانی و مواد مغذی ، کاهش دردهای مرتبط به ناحیه تناسلی، افزایش میل جنسی و تحریکات جنسی در ناحیه ژنییتال و ... پرداخته شده است.

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THE POTENTIAL OF CARBOXYTHERAPY IN DISEASES OF THE UROGENITAL SYSTEM ORGANS

Recently carboxytherapy has been widely used for the treatment of many diseases, and it is associated with the high efficiency and low cost. Carboxytherapy as the method of treatment has been used for 70 years in the international medical practice and more than 50 years in aesthetic medicine.

Aim. To substantiate the use of carboxytherapy as an innovative method of treatment for diseases of the urogenital system organs.

Materials and methods. The analysis of scientific sources concerning the treatment of sexual dysfunction, erosion of the cervix, menopause, vulvovaginal atrophy, initial stages of the stress urinary incontinence, erectile dysfunction, and impotence was performed.

Results. It has been determined that various variants of carboxytherapy can be used to obtain the antihypoxic, reparative-regenerative, spasmolytic, anti-inflammatory, analgesic and antioxidant effects in clinical practice as a result of the treatment. Patients with different pathologies of the urogenital system noted improvement in functioning of urogenital organs, release of pain, decrease in inflammation, mood stability, and good mental and physical performance. Therefore, the quality of life has been improved.

Conclusions. Thus, CO₂ can be considered as a unique medicinal product, and carboxytherapy as an alternative treatment for many diseases.

Key words: carboxytherapy; carbon dioxide; hypoxia; oxygenation; diseases of the urogenital system

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Можливості карбокситерапії при захворюваннях органів сечостатевої системи

Останнім часом карбокситерапія широко застосовується для лікування багатьох захворювань, що пов'язано з високою ефективністю і дешевизною даного методу. Карбокситерапія як альтернативний метод лікування використовується впродовж 70 років у світовій медичній практиці і більше 50 років в естетичній медицині.

Мета роботи. Обґрунтування застосування інноваційного методу лікування – карбокситерапії при захворюваннях органів сечостатевої системи.

Матеріали та методи. Аналіз літератури проводили шляхом опрацювання наукових статей щодо лікування сексуальної дисфункції, ерозії шийки матки, клімаксу, вульвовагінальної атрофії, початкових стадій стресового нетримання сечі, еректильної дисфункції, імпотенції.

Результати. Встановлено, що в клінічній практиці використовуються різні варіанти карбокситерапії для отримання антигіпоксичного, репаративно-регенеративного, спазмолітичного, протизапального, анальгезуючого та антиоксидантного ефектів. У результаті пацієнти з різними патологіями органів сечостатевої системи відзначають поліпшення самопочуття, покращення функціонування цих органів, усунення болю, запалення, підвищення настрою, розумової і фізичної працездатності, а в цілому і якості життя.

Висновки. Таким чином, можна вважати CO₂ унікальним лікарським засобом, а карбокситерапію альтернативним методом лікування при багатьох захворюваннях.

Ключові слова: карбокситерапія; вуглекислий газ; гіпоксія; оксигенація; захворювання сечостатевої системи

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Возможности карбокситерапии при заболеваниях органов мочеполовой системы

В последнее время карбокситерапия широко применяется для лечения многих заболеваний, что связано с высокоэффективностью и дешевизной данного метода. Карбокситерапия как метод лечения используется на протяжении 70 лет в мировой медицинской практике и более 50 лет в эстетической медицине.

Цель работы. Обоснование применения инновационного метода лечения – карбокситерапии при заболеваниях органов мочеполовой системы.

Материалы и методы. Анализ литературы проводили путем обработки научных статей относительно лечения сексуальной дисфункции, эрозии шейки матки, климакса, вульвовагинальной атрофии, начальных стадий стрессового недержания мочи, эректильной дисфункции, импотенции.

Результаты. Установлено, что в клинической практике используются различные варианты карбокситерапии для получения антигипоксического, репаративно-регенеративного, спазмолитического, противовоспалительного, анальгезирующего и антиоксидантного эффектов. В результате лечения пациенты с различными патологиями органов мочеполовой системы отмечали улучшение самочувствия, улучшение функционирования этих органов, устранение боли, воспаления, повышение настроения, умственной и физической работоспособности, а следовательно и качества жизни.

Выводы. Таким образом, можно считать CO₂ уникальным лекарственным средством, а карбокситерапию альтернативным методом лечения при многих заболеваниях.

Ключевые слова: карбокситерапия; углекислый газ; гипоксия; оксигенация; заболевания мочеполовой системы

One of the main etiological factors in development of the pelvic organ pathology is a decrease in the blood circulation of these organs leading to hypoxia. Hypoxia precedes development of sexual, gynecological, andrological and nephrological dysfunction of pelvic organs.

The oxygen transport function of the body is impossible without carbon dioxide since hemoglobin gives oxygen to tissues, instead it receives carbon dioxide [1, 2]. Carbon dioxide is the most important product of cellular respiration; therefore, there are many sensors in the body that regulate the concentration of this gas. The shift of the CO₂ level from the physiological values triggers numerous adaptation reactions. For instance, if the partial pressure of CO₂ decreases in the alveolar air, hypocapnia develops, and the respiratory center activity decreases; moreover, in some cases it can lead to apnea. The CO₂ concentration increase automatically serves as a signal for increasing the intensity of breathing and the blood circulation; due to tissues oxygenation the muscle tension and spasms decrease; it provides the analgesic and anti-inflammatory effect, and the body's resistance to harmful factors increases [3, 4].

One of the innovative methods for treating pelvic organs is carboxytherapy, which causes dilatation of blood vessels. It also has the antihypoxic, anti-inflammatory, analgesic effects, improves the psychological condition of patients [5, 6]. Elimination of hypoxia reduces formation of underoxidized products (the antioxidant effect of carboxytherapy) [3, 7].

Carboxytherapy is an alternative method for treating diseases of the urogenital system. It can be used in combination with other therapeutic methods to enhance the analgesic, anti-inflammatory, spasmolytic and other positive effects. Carboxytherapy significantly reduces the dose of other drugs used [7, 8].

The main complaints in gynecological diseases are dysfunction of the menstrual cycle, pain in the lower abdomen, sexual dysfunction and infertility [8]. The age-related sexual dysfunction occurs in 30-50 % of women. The cause of it is a decrease in the blood circulation due to the atherosclerotic pathology when there is vaginal and muscular fibrosis, postmenopausal changes (decrease in the estrogen level, change in the vaginal flora). Carboxytherapy

stimulating the endothelial vascular growth factor, endothelial proliferation, angiogenesis, vasodilation, oxygenation eliminates vaginal dryness in 80 % of women, improves libido and sexual sensitivity in 75 % of patients [9, 10]. Carboxytherapy can help to renew the blood supply of the pelvic organs; it also normalizes the vaginal flora, and eliminates the symptoms of the vaginal mucosa dryness [11].

Vulvovaginal atrophy is a problem, which 50 % of women face during the menopause. It can be accompanied with such symptoms as itching, vaginal bleeding during sexual activities, leucorrhoea, etc. [12, 13]. Several alternative therapies are used for this disease, including carboxytherapy. The fractional CO₂ laser with pulsed radiation has been designed specifically to treat the mucous membrane of the vagina (SmartXide²V²LR laser system DEKA MELA, Italy). CO₂ affects the vaginal mucosa microcirculation and improves the tissue trophism due to stimulation of the collagen synthesis and activation of fibroblasts. The clinical study conducted on 40 patients showed significant positive histological changes after the treatment with CO₂ by a laser and a significant positive effect on the symptoms of vaginal atrophy [12]. The effectiveness of treatment with these methods is accompanied by formation of elastic fibers, stimulation of neocollagenesis, restoration of the acid pH and proper moistening. On the whole, carboxytherapy improves the condition of a patient with climacteric vaginal atrophy symptoms [12, 14, 15].

Traditional methods of the climacteric vaginal atrophy treatment are limited only by the local effect on the vagina mucous membrane, and these effects are temporary and reversible. The treatment with the fractional micro-ablative CO₂ laser not only induces molecular changes at the site of injury, but also has a permanent long-term effect [14].

Erection occurs as a result of changes in the blood circulation in the penis due to reduction of the smooth muscle vessels under the action of sympathetic nerves activities [16].

Erectile dysfunction in men (persistent inability to achieve and maintain erection, which is sufficient for the sexual activity) is associated with microangiopathy, it occurs in approximately 50 % of men.

However, only 16 % of them visit a doctor since this problem has a psychological background [16]. Problems associated with erectile dysfunction are increasing with age. This is associated with emergence of risk factors: chronic diseases, obesity, diabetes mellitus, microangiopathy, arterial hypertension, increased cholesterol level, atherosclerosis [17]. Psychological disorders because of erectile dysfunction can be more devastating than the pathological problems of a chronic medical condition. Erectile dysfunction and depression are interrelated: in 50-90 % of patients with depression there is a decreased interest in sex, and on the contrary, erectile dysfunction leads to an increase of depression.

Impotence is much broader term that includes not only the problems with erection, but also with the sexual desire (libido), ejaculation or achievement of orgasm (culmination) [18]. According to the Massachusetts study of aging in men [19] 52 % of men between 40 and 70 years suffer from impotence. The frequency of this disorder increases with age. Risk factors for erectile dysfunction and impotence include arterial hypertension, hypercholesterolemia, diabetes mellitus and other peripheral vascular diseases when hypoxia of the pelvic organs occurs.

Carboxytherapy is an innovative medical technology aimed at the non-invasive and painless treatment of erectile dysfunction. The goal of this therapy is to increase the blood circulation and oxygenation in the pelvic organs, improve the erection with the reflex action (by analogy with the shock wave) [8].

Due to the pharmacological properties of CO₂ carboxytherapy is able to affect pathogenesis of these pathologies, reducing symptoms and improving the patients' quality of life [10]. Today, doctors' experience covers 30 years of carboxytherapy in gynecology, andrology, urology and nephrology, in the treatment of diseases of the prostate and urinary system.

The mechanism of the carboxytherapy action in diseases of the urogenital system is associated with an increase in tissue oxygenation due to the Bohr effect: it shows the effect of the CO₂ concentration and the pH value on the process of binding and releasing of O₂ from hemoglobin [9]. The process of CO₂ and O₂ gas exchange occurs both in lungs, kidneys, uterus, and in the prostate gland [10]. The effectiveness of binding hemoglobin to carbon dioxide (with formation of carbhemoglobin) is inversely related to binding to oxygen. In tissues the part of the excessive CO₂ binds to hemoglobin, and it promotes the release of oxygen and tissue oxygenation.

All cells of the body (neurons, hepatocytes, cardiomyocytes, epitheliocytes, etc.), release CO₂ as a product of vital activity and the final product of biochemical reactions. The process of CO₂ elimination

from the body through the lungs increases the tissue oxygenation. One part of CO₂ increases the concentration of oxygen in tissues more than 3 times. Consequently, when tissues are saturated with oxygen, its release from tissues decreases and it causes vasoconstriction with a decrease in the local blood circulation. The excess of CO₂ (hypercapnia) dilates blood vessels, increases delivery of oxygen and nutrients to tissues [7].

Being a powerful natural vasodilator CO₂ reduces the basal tone of the arterioles and promotes the increased blood circulation. The body interprets the procedure of carboxytherapy as oxygen deficiency and reacts by increasing the blood circulation and VEGF (vascular endothelial growth factor), which stimulates neoangiogenesis. Thus, in perspective, carboxytherapy improves the blood circulation in the pelvic organs due to appearance of new vessels and the arterial blood influx to the penis and other organs [10].

Other modern mechanisms of the carboxytherapy action for pelvic organs are also associated with physiological properties of CO₂. Invasive introduction of CO₂ (carboxytherapy) causes imbalance of the physiological correlation between CO₂ and O₂ volumes in tissues. The increased content of CO₂ in tissues causes stress in the body, and the body copes it with the help of the own reserves. Due to the action of CO₂ in the body the main mechanisms of homeostasis adaptation start; they are a neurohumoral reaction that involves the hypothalamic-pituitary system of the endogenous pain regulation, optimization of the antinociceptive self-regulation (stimulation of the endogenous synthesis of endorphines that provide the analgesic effect). Pomerants B. also stated that the analgesic effect of carbon dioxide injections is associated with the endorphine synthesis [10]. The placebo effect also has no small share: release of endorphines and the placebo effect are in close synergy when conducting carboxytherapy.

Invasive carboxytherapy has been used for a long time as an auxiliary treatment for diseases of the urogenital system. It slows down the signs of sexual aging, treats cervical erosion, leukoplakia; polycystosis, endometriosis, menopause, vulvovaginal atrophy, amenorrhea and oligomenorrhoea, the initial stages of the stress urinary incontinence; it is also used in medical and diagnostic laparoscopy. Vaginal rejuvenation with the help of carboxytherapy occurs due to the increased blood supply to pelvic organs and normalization of the vaginal flora. It also eliminates the symptom of dryness of the vaginal mucosa [9, 11]. Carboxytherapy acts on the level of microcirculation of arterioles and precapillary sphincters by increasing the rate of the blood flow in tissues, as well as by improving lymphatic drainage. These mechanisms of the CO₂ action are

widely used in inflammatory diseases of the urogenital system accompanied with hypoxia, edema [10, 20].

At the site of CO₂ injection the nerve endings sensitivity changes, muscle fibers relax (these changes contribute to the analgesic effect of CO₂), the tissue trophism and the local protective processes improve. In addition, the body's resistance to unfavorable environmental factors increases due to the pronounced antioxidant effect of CO₂ [7].

Invasive carboxytherapy in gynecology is used for the treatment of pain in the lower abdomen (painful menstruation, conditions after operations – adhesions). The pressure of CO₂ at the injection site causes the flow of impulses from baroreceptors, while rapid pH change to alkali (alkalosis) at the site of CO₂ injection affects chemoreceptors, and it contributes to the analgesic and spasmolytic effects [7]. In addition, relaxation of the muscle fibers of the vessels is due to a decrease in the amount of Ca²⁺ calcium ions (formation of calcium bicarbonate during dissociation of carbonic acid), and it leads to local vasodilation and acceleration of microcirculation [10].

In 1981, Dr. Kovarzhik developed and patented the method of CO₂ medical commercial use called "Bioterik". For this purpose special hygienic and harmless polyethylene bags with CO₂ are used. Taking into account the peculiarities of this procedure a patient does not inhale CO₂ during carboxytherapy (the CO₂ concentration in the bag is almost 100 %). This procedure is used in women as an analgesic therapy in painful menstruation and during the menopause [4, 14].

Thus, carboxytherapy is an auxiliary and alternative therapy with a successful positive result for improving the circulation of the pelvic organs with the gynecological, andrological and nephrologic dysfunction.

This innovative technology is designed to improve the local blood circulation which is achieved by subcutaneous administration of CO₂ in pelvic organs. In order to improve blood circulation in this area the action similar to shock wave therapy is used. It has the anti-inflammatory, analgesic, anti-hypoxic, vasodilating, angio-stimulating and antioxidant action. The fibroblast activation and collagen synthesis occur, and carboxytherapy provides faster recovery of the pH level and normalization of the vaginal mucosa [21, 22].

Carbon dioxide is also used as an alternative contrast substance for diagnosis in diseases of urogenital system. From economic point of view, the use of CO₂ significantly reduces the cost of diagnostic procedures in the peripheral angiography, diagnosing bleeding in patients with renal insufficiency or

examining of the fallopian tubes [9]. Thus, carbon dioxide due to its antibacterial properties (for the aerobic microflora) and the absence of side effects is an important component of diagnostic procedures for diseases of the urogenital system.

The purpose of non-invasive carboxytherapy (carbon dioxide baths) is to mobilize the body's defenses, restore the balance of the nervous processes, increase the oxygen content in the arterial blood and improve all metabolic (carbohydrate, fatty, protein) processes in the body [4]. Carbonic baths have the vasodilating, analgesic, bactericidal and spasmolytic effects and also cause oxygenation appearing from dilation of arteries and capillaries. Carbonic mineral baths are used in pathologies of the urogenital, endocrine and immune systems as they improve the blood supply of the body and accelerate removal of toxic substances from it, reduce pain due to their analgesic, reparative-regenerative, spasmolytic and anti-inflammatory properties [4].

"Dry" CO₂ baths help to reduce toxic symptoms after chemotherapy; increase the physical and sexual activity of men and women, reduce menopausal symptoms; they are used in inflammation of the bladder and other organs of the small pelvis, as well as in the treatment of infertility [1, 3, 4].

In balneology CO₂ baths are recommended for the following diseases of the sexual system: impotence, chronic inflammatory diseases of female genital organs in remission (adnexitis, salpingoophoritis, menopause), ovarian dysfunction [20].

Thus, in clinical practice various variants of carboxytherapy are used to obtain the antihypoxic, reparative-regenerative, spasmolytic, anti-inflammatory, analgesic and antioxidant effects. As a result, patients with pathologies of various organs of the urogenital system note improvement in functioning of urogenital organs, release of pain, decrease in inflammation, mood stability, and good mental and physical performance. Therefore, the quality of life has been improved.

Contraindications of carboxytherapy are nephritis and nephrosis. In case of these diseases the treatment using this method should be withheld.

At present, carboxytherapy is widely used in all areas of medical practice as it is a highly effective and safe method of treating many diseases. This method of treatment has been used for 70 years in the world medical practice and more than 50 years in aesthetic medicine. Thus, it is possible to consider CO₂ to be a unique drug, and carboxytherapy to be an alternative method in off-label therapy for many diseases.

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References

1. Effects of repeated carbon dioxide-rich water bathing on core temperature, cutaneous blood flow and thermal sensation / N. Nishimura, J. Sugeno, T. Matsumoto et al. // *Eur. J. Appl. Physiol.* – 2002. – Vol. 87, Issue 4–5. – P. 337–342. doi: 10.1007/s00421-002-0626-0
2. Румянцова, Е. Карбокситерапия от общего к частному / Е. Румянцова, С. Блидар // *Инъекционные методы в косметол.* – 2010. – № 23. – С. 146–152.
3. Физиологические свойства CO₂ – обоснование уникальности карбокситерапии / С. М. Дроговоз, С. Ю. Штрыголь, М. В. Зупанец и др. // *Медична та клінічна хімія.* – 2016. – Т. 18, № 1. – С. 112–116.
4. Уникальность фармакотерапевтических возможностей углекислого газа (карбокситерапии) / С. М. Дроговоз, С. Ю. Штрыголь, М. В. Зупанец и др. // *Рациональная фармакотерапия.* – 2016. – № 1. – С. 37–39.
5. Фармакологическое обоснование карбокситерапии в дерматологии / С. М. Дроговоз, С. Ю. Штрыголь, Л. Б. Иванцык, А. В. Кононенко // *Укр. журн. дерматол., венерол., косметол.* – 2016. – С. 105–108.
6. Андріюк, Л. В. Застосування вуглекислого газу в медичній реабілітації : метод. рек. / Л. В. Андріюк, О. Р. Зав'ялова, Н. В. Мацко. – Львів : Папуга, 2014. – 104 с.
7. Фармакологическое обоснование карбокситерапии (CO₂-терапии) / С. М. Дроговоз, С. Ю. Штрыголь, А. В. Кононенко, М. В. Зупанец // *Фармакол. и лекарственная токсикол.* – 2017. – № 1 (52). – С. 73–78.
8. Карбокситерапия – стиль off label use (лекарства вне инструкции) / В. П. Черных, С. М. Дроговоз, И. А. Зупанец и др. // *Лікарська справа.* – 2017. – № 5–6. – С. 111–116.
9. Механизм действия карбокситерапии / С. М. Дроговоз, С. Ю. Штрыголь, А. В. Кононенко и др. // *Фармакол. и лекарственная токсикол.* – 2016. – № 6 (51). – С. 12–20.
10. Карбокситерапия – альтернатива традиционной фармакотерапии / С. М. Дроговоз, С. Ю. Штрыголь, М. В. Зупанец и др. // *Клиническая фармакол.* – 2016. – Т. 20, № 1. – С. 12–17.
11. Anger, J. T. CO₂ Laser treatment is effective for symptoms of vaginal atrophy / J. T. Anger // *J. of Urol.* – 2017. – Vol. 198, Issue 6. – P. 1228–1229. doi: 10.1016/j.juro.2017.09.003
12. Gonzalez, P. Tratamiento de la atrofia vaginal en la menopausia con laser de CO₂ fraccional microablativo / P. Gonzalez, A. I. Ruiz, L. Galindo // *Rev. Enfer. Tract Gen. Inf.* – 2014. – Vol. 8. – P. 36–40.
13. Carboxytherapy local treatment of vaginal mucosa atrophy or hypotrophy of vaginal mucosa at menopause and postpartum / J. Elias, A. Carbone, A. Gaspar et al. // *Intern. J. of Gynecol. & Obstetrics.* – 2012. – Vol. 119. – P. S563–S564.
14. Fractional CO₂ laser : from skin rejuvenation to vulvo-vaginal reshaping / M. Filippini, E. Del Duca, F. Negosanti et al. // *Photomed. Laser Surg.* – 2017. – Vol. 35, Issue 3. – P. 171–175. doi: 10.1089/pho.2016.4173
15. The role of carbon dioxide therapy in the treatment of chronic wounds / C. Brandi, L. Grimaldi, G. Nisi et al. // *In Vivo.* – 2010. – Vol. 24, Issue 2. – P. 223–229.
16. Эректильная дисфункция : причины и способы лечения // *Лекарственный справочник.* – 2014. – № 3 (15). – С. 72–73.
17. Randrup, E. Erectile dysfunction and cardiovascular disease / E. Randrup, N. Baum, A. Feibus // *Postgrad. Med.* – 2015. – Vol. 127, Issue 2. – P. 166–72.
18. Курочка, Д. Мужские достоинства, или особенности гендерной анатомии / Д. Курочка // *Провизор.* – 2011. – № 7. – С. 59–60.
19. O'Donnell, A. B. The health of normally aging men: The Massachusetts Male Aging Study (1987–2004) / A. B. O'Donnell, A. B. Araujo, J. B. McKinlay // *Exp. Gerontol.* – 2004. – Vol. 39, Issue 7. – P. 975–984. doi: 10.1016/j.exger.2004.03.023
20. Дроговоз, С. М. Механизмы действия и фармакотерапевтические возможности карбокситерапии при заболеваниях нервной системы / С. М. Дроговоз, В. И. Кабачный, И. В. Кабачная // *Укр. вісник психоневрол.* – 2016. – Т. 24, № 3 (88). – С. 83–86.
21. Sinozic, T. Carboxytherapy – supportive therapy in chronic wound treatment / T. Sinozic, J. Kovacevic // *Acta Med. Croatica.* – 2013. – Vol. 67, Issue 1. – P. 137–141.
22. Acupuncture for chronic knee pain a randomized clinical trial / R. S. Hinman, P. McCrory, M. Pirotta et al. // *JAMA.* – 2014. – Vol. 312, Issue 13. – P. 1313–1322.

References

1. Nishimura, N., Sugeno, J., Matsumoto, T., Kato, M., Sakakibara, H., Nishiyama, T., Ogata, A. (2002). Effects of repeated carbon dioxide-rich water bathing on core temperature, cutaneous blood flow and thermal sensation. *European Journal of Applied Physiology*, 87 (4–5), 337–342. doi: 10.1007/s00421-002-0626-0
2. Rumiantceva, E., Blidar, S. (2010). *Inekcionnye metody v kosmetologii*, 23, 146–152.
3. Drogovoz, S. M., Shtrygol, S. Yu., Zupanec, M. V. et al. (2016). *Medychna ta klinichna khimiia*, 18 (1), 112–116.
4. Drogovoz, S. M., Shtrygol, S. Yu., Zupanec, M. V. et al. (2016). *Ratcionalnaia farmakoterapiia*, 1, 37–39.
5. Drogovoz, S. M., Shtrygol, S. Yu., Ivantcyk, L. B., Kononenko, A. V. (2016). *Ukrainskyi zhurnal dermatolohii, venerolohii, kosmetolohii*, 61 (2), 105–108.
6. Andriiuk, L. V., Zavialova, O. R., Matsko, N. V. (2014). *Zastosuvannia vuhlekysloho hazu v medychnii rehabilitatsii*. Lviv: Papuha, 104.
7. Drogovoz, S. M., Shtrygol, S. Yu., Kononenko, A. V., Zupanec, M. V. (2017). *Farmakologiiia i lekarstvennaia toksikologiiia*, 1 (52), 73–78.
8. Chernykh, V. P., Drogovoz, S. M., Zupanec, I. A. et al. (2017). *Likarska sprava*, 5–6, 111–116.
9. Drogovoz, S. M., Shtrygol, S. Yu., Kononenko, A. V. et al. (2016). *Farmakologiiia i lekarstvennaia toksikologiiia*, 6 (51), 12–20.
10. Drogovoz, S. M., Shtrygol, S. Yu., Zupanec, M. V. et al. (2016). *Klinicheskaia farmakologiiia*, 20 (1), 12–17.
11. Anger, J. T. (2017). CO₂ Laser Treatment is Effective for Symptoms of Vaginal Atrophy. *The Journal of Urology*, 198 (6), 1228–1229. doi: 10.1016/j.juro.2017.09.003

12. Gonzalez, P., Ruiz, A. I., Galindo, L. (2014). Tratamiento de la atrofia vaginal en la menopausia con laser de CO₂ fraccional microablative. *Rev Enfer Tract Gen Inf*, 8, 36–40.
13. Elias, J., Carbone, A., Gaspar, A. et al. (2012). Carboxytherapy local treatment of vaginal mucosa atrophy or hypotrophy of vaginal mucosa at menopause and postpartum. *International Journal of Gynecology & Obstetrics*, 119, S563–S564.
14. Filippini, M., Del Duca, E., Negosanti, F., Bonciani, D., Negosanti, L., Sannino, M., Nisticò, S. P. (2017). Fractional CO₂ Laser: From Skin Rejuvenation to Vulvo-Vaginal Reshaping. *Photomedicine and Laser Surgery*, 35 (3), 171–175. doi: 10.1089/pho.2016.4173
15. Brandi, C., Grimaldi, L., Nisi, G. et al. (2010). The role of carbon dioxide therapy in the treatment of chronic wounds. *In Vivo*, 24 (2), 223–229.
16. Erekttilnaia disfunktsiia: prichiny i sposoby lecheniia (2014). *Lekarstvennyi spravochnik*, 3 (15), 72–73.
17. Randrup, E., Baum, N., Feibus, A. (2015). Erectile dysfunction and cardiovascular disease. *Postgrad Med*, 127 (2), 166–72.
18. Kurochka, D. (2011). *Provizor*, 7, 59–60.
19. O'Donnell, A. B., Araujo, A. B., McKinlay, J. B. (2004). The health of normally aging men: The Massachusetts Male Aging Study (1987–2004). *Experimental Gerontology*, 39 (7), 975–984. doi: 10.1016/j.exger.2004.03.023
20. Drogozov, S. M., Kabachnyi, V. I., Kabachna, I. V. (2016). *Ukrainskyi visnyk psykhonevrolohii*, 3 (88), 83–86.
21. Sinozic, T., Kovacevic, J. (2013). Carboxytherapy – supportive therapy in chronic wound treatment. *Acta Med. Croatica*, 67 (1), 137–141.
22. Hinman, R. S., McCrory, P., Pirota, M. et al. (2014). Acupuncture for chronic knee pain a randomized clinical trial. *JAMA*, 312 (13), 1313–1322.

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