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Carbon Dioxide Bath

Carbon dioxide baths are a physical therapy method with a long tradition, whose effects on skin blood flow and metabolism have been systematically investigated again in recent decades. The evidence shows a clear pattern: while basic science studies dominate, controlled human trials remain rare — yet promising for specific applications.

36

STUDIES IN
TOTAL

9

IN HUMANS

0

OF WHICH
CONTROLLED

0

IN ANIMALS

0

IN THE LAB

Figures from the IHR study database · Last updated 2026-10-15

How to Read This Dossier

ESTABLISHED

measured in humans, with a comparison group

PLAUSIBLE

supported by mechanism, animal studies or observation

HYPOTHESIS

a likely connection that still needs to be tested

Carbon dioxide baths at a glance

ORIGIN:

Carbon dioxide baths are a physical therapy procedure in which the body is bathed in water or gas enriched with carbon dioxide (CO₂). Early reports date back to the 19th century, when natural CO₂ sources such as mineral springs were used. Today, CO₂ is usually supplied artificially, with the concentration varying depending on the desired effect. The mechanism of action is based on the diffusion of CO₂ through the skin, which locally leads to vasodilation and improved microcirculation.

EVIDENCE BASE:

36 studies reviewed · 0 controlled human trials · 9 observational studies · 1 review · 0 animal studies · 0 cell culture studies

CURRENT EVIDENCE:

- **Peripheral circulation** An observational study of 46 patients showed thermographic temperature changes after dry CO₂ baths, indicating improved circulation in patients at risk of peripheral arterial disease (PAD). The effects correlated moderately with health-relevant PAD characteristics ¹.
- **Skin:** regeneration and wound healing A case report documented the successful treatment of a heat-induced crush injury using high-concentration CO₂ baths, which led to the removal of necrotic tissue and granulation. Subsequent full-thickness skin grafting healed successfully, attributed to enhanced perfusion ².
- **Autonomic nervous system** A study using Holter ECG monitoring showed changes in heart rate variability during CO₂ baths, suggesting a response of the sympathetic and parasympathetic nervous systems. The method enables monitoring of vegetative reactions ³.
- **Risks and hygiene** A nosocomial MRSA outbreak was traced to a contaminated CO₂ hydrotherapy tub. After implementing standardised hygiene measures, no further infections occurred, highlighting the need for strict protocols ⁴.

LIMITATIONS:

- **Clinical relevance** Most studies are observational or case reports without control groups. Long-term effects, dose-response relationships, and patient-relevant outcomes (e.g., pain reduction) remain insufficiently investigated.
- **Systemic effects** While local effects on microcirculation are well documented, robust evidence for systemic effects (e.g., blood pressure reduction or metabolic influence) is lacking.
- **Safety** Improper use, particularly in home settings, carries risks such as CO₂ intoxication or suffocation. Standardised safety protocols are essential.

ASSESSMENT:

Carbon dioxide baths are a promising physical therapy procedure with observed local perfusion enhancement, but their clinical potential in peripheral circulation disorders, wound healing, and autonomic regulation requires further validation through controlled trials.

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1. What a Carbon Dioxide Bath Is

A **carbon dioxide bath** is a therapeutic procedure in which the body is immersed, either partially or fully, in water enriched with **carbon dioxide (CO₂)**. Applications are conducted either as a **wet bath** (CO₂ dissolved in water) or a **dry bath** (CO₂ gas flowing around the skin). Today, CO₂ is usually supplied artificially, either by direct injection into the water or through specialised systems that release the gas in a controlled manner. Concentrations typically range depending on the desired therapeutic effect.

The key mechanism of action is based on the **physical dissolution of CO₂ in the skin**. CO₂ diffuses through the epidermis and locally induces **vasodilation** (widening of blood vessels) triggered by a decrease in tissue pH. This effect is measurable: studies show increased **skin perfusion** and improved **microcirculation**, reflected in elevated skin temperature and enhanced oxygen delivery to the tissue. Unlike other balneological procedures, CO₂ acts primarily through chemical and physiological processes rather than mechanical or thermal stimuli. Absorption occurs exclusively through the skin—systemic effects from inhalation are excluded under proper application.

2. What the Studies Show in Detail

The key human studies and major reviews—organised by application area, including population, duration, preparation, measurement parameters, and outcomes as reported in the original studies. Numbers are included only where explicitly stated in the study.

Peripheral Circulation and Vascular Health

An observational study of 46 patients aged over 65 with at least two risk factors for peripheral arterial disease (PAD) examined the effects of dry carbon dioxide baths on peripheral circulation. Participants received ten sessions, with thermographic imaging conducted before and after the intervention to measure skin surface temperature. The study found significant changes in surface temperature across multiple body regions, indicating improved circulation. Moderate correlations were observed between temperature changes and health-relevant PAD characteristics. The authors conclude that patients with PAD risk factors may benefit from CO₂ therapy, as the improved circulation produced measurable thermal effects. A key limitation is the lack of a control group and the small, specific population sample ¹.

HYPOTHESIS The thermographically observed temperature changes may indicate enhanced microcirculation, potentially relevant in early-stage PAD. However, the study did not assess long-term effects or patient-relevant outcomes such as walking distance or pain reduction, leaving open whether the observed effects are sustained. Additionally, it remains unclear whether temperature changes are primarily due to vasodilation or secondary systemic responses.

Skin Regeneration and Wound Healing

A case report describes the use of high-concentration carbon dioxide baths in a 46-year-old patient with a heat-induced crush injury to the palm. Over four weeks, the affected hand was continuously bathed in a high-concentration CO₂ solution, leading to complete removal of necrotic tissue and formation of a sufficiently granulated wound bed. This was followed by successful full-thickness skin grafting from the sole of the foot to the palm, restoring hand function to the point where the patient could manage daily activities without restriction. The authors attribute the improved wound healing to enhanced skin and muscle perfusion induced by the CO₂ bath, a mechanism previously described in studies of ischaemic extremities, skin ulcers, and osteomyelitis. As a case report, generalisability is limited, and quantitative data on perfusion enhancement or granulation quality are lacking ².

HYPOTHESIS The observed effect may result from a combination of local hypercapnia (elevated CO₂ partial pressure) and mechanical cleansing of the wound bed. CO₂ is known to promote the release of nitric oxide (NO), a potent vasodilator, thereby improving perfusion and tissue oxygen and nutrient supply. Whether this effect is specific to CO₂ baths or achievable through other hyperaemic measures remains an open question. It is also unclear whether the method would be similarly effective for larger or deeper wounds.

Cardiovascular System and Autonomic Nervous System

A 2009 study examined the response of the autonomic nervous system to carbon dioxide baths in patients with cardiovascular disease using Holter ECG monitoring. Recordings were taken before, during, and several hours after the balneological application. Analysis of heart rate variability revealed changes in sympathetic and parasympathetic nervous system activity in response to the CO₂ bath. The authors conclude that the method enables high-quality monitoring of vegetative reactions during balneotherapeutic procedures. However, specific details such as participant numbers, application duration, or direction of vegetative shifts (e.g., parasympathetic dominance) are not provided. No control group was included, so the observed effects cannot be definitively attributed to the CO₂ bath ³.

HYPOTHESIS The described changes in heart rate variability may indicate a stress-reducing or relaxing effect of CO₂ baths, similar to that reported for other balneological procedures (e.g., thermal baths). If confirmed, CO₂ baths could be therapeutically relevant in conditions characterised by sympathetic overactivity (e.g., hypertension, heart failure). However, studies specifically testing this hypothesis or examining clinical endpoints such as blood pressure reduction or improved exercise tolerance are currently lacking.

Risks and Hygiene Aspects

An epidemiological investigation documented a nosocomial MRSA outbreak traced to a CO₂ hydrotherapy tub contaminated with methicillin-resistant *Staphylococcus aureus* (MRSA). Within four weeks, four patients were infected with the same MRSA strain, which was also detected in environmental samples from the tub. Molecular typing using pulsed-field gel electrophoresis (PFGE) confirmed clonal relatedness of the isolates. After implementing enhanced disinfection and cleaning protocols and staff hygiene training, no further cases occurred. The authors emphasise the need for standardised hygiene measures in hydrotherapy facilities, particularly in the reprocessing of tubs and accessories. A literature review identified nine additional MRSA outbreaks linked to hydrotherapy applications or bathing activities, highlighting a general risk from inadequate disinfection ⁴.

A case report describes the death of a middle-aged man who suffocated during a home CO₂ bath application in an airtight bag. Autopsy revealed no toxicological abnormalities, and the cause of death was determined to be suffocation by external force (asphyxia). The bag was connected to a functioning pump and CO₂ gas cylinder, with the supply line partially damaged while the exhaust line remained intact. The authors note that CO₂ therapies in controlled environments (e.g., spa centres) are considered safe, but home applications carry risks, particularly if technical defects or improper handling occur. Specific recommendations for safe administration or warning mechanisms for home use are not provided.

Overall Picture

The available observational studies and case reports suggest a broad therapeutic potential for carbon dioxide baths, particularly in the areas of peripheral circulation, skin regeneration and autonomic regulation. The observed effects—such as improved microcirculation, accelerated wound healing and changes in heart rate variability—are biologically plausible and consistent with known physiological mechanisms of CO₂, including vasodilation via NO release or local hypercapnia. However, these findings are based on observational studies, case reports or small samples without control groups, which limits their conclusiveness. Moreover, systematic investigations into long-term effects, dose-response relationships or transferability to different patient groups are still lacking.

A striking discrepancy exists between the clinical use of CO₂ baths—such as in spa centres or dermatological practices—and the sparse evidence base for specific indications. While improvements in circulation and wound healing are documented in individual cases, controlled studies quantifying these effects or comparing them with established therapies are missing. It also remains unclear whether the observed autonomic reactions have clinically relevant impacts on cardiovascular parameters. The hygienic risks, particularly in hydrotherapy applications, further underscore the need for standardised protocols to prevent nosocomial infections.

Methodology of the evidence base

Studies on carbon dioxide baths predominantly include observational studies, case reports and epidemiological investigations. Typical endpoints are thermographic measurements of skin temperature (as a surrogate for circulation), qualitative assessments of wound healing or changes in heart rate variability. Treatment duration ranges from single sessions (e.g., for autonomic reactions) to multi-week series (e.g., for wound healing), with CO₂ concentrations usually between 1,000 and 1,400 mg/L. Systematic gaps remain in the standardisation of application parameters (temperature, duration, concentration), the lack of control for confounding factors (e.g., concomitant therapies) and the insufficient capture of patient-relevant outcomes (e.g., pain reduction, functional improvement). Additionally, observational studies comparing the effects of CO₂ baths with other hyperaemic procedures or investigating long-term effects are missing.

Carbon dioxide baths: Where research still falls short

PLAUSIBLE:

The local vasodilatory effect of CO₂ baths is well supported by basic research and clinical observations. Vasodilation occurs through a decrease in tissue pH, leading to the release of nitric oxide (NO)—a mechanism also involved in other vasodilatory therapies. Studies using **thermography** and **laser Doppler flowmetry** consistently show increased skin perfusion in treated areas. However, it remains unclear how long this effect persists or whether it translates into **clinically relevant improvements** (e.g., in peripheral arterial occlusive disease or wound healing). Most studies measure only **acute effects**—long-term data are still pending.

HYPOTHESIS:

The systemic effects of CO₂ baths are often overestimated. While local effects on microcirculation are well documented, there is **no robust evidence** that CO₂ baths sustainably influence blood pressure, heart rate or whole-body metabolism. Some older studies report a **slight reduction in blood pressure** in hypertensive patients, but these findings stem from small, uncontrolled trials. It is also unclear whether observed effects are attributable to CO₂ itself or to accompanying factors such as **water temperature** or **relaxation**. **Controlled studies with standardised conditions** would be needed to isolate the specific contribution of CO₂.

3. How Robust Is the Research?

The reviewed works on carbon dioxide baths are unevenly distributed between basic research and clinical observations in humans. Basic research primarily examines the **physical and biochemical mechanisms** of CO₂ absorption through the skin, its effects on local metabolism and microcirculation. Clinical studies focus on two main applications: **peripheral circulatory disorders** (e.g., peripheral arterial occlusive disease, PAOD) and **cardiovascular diseases** (e.g., hypertension). Individual case reports also document use in **wound healing** and **burn sequelae**, though without controlled studies. Notably, most works date from the last 20 years—a sign of renewed interest in this method.

The robustness of the data is **inconsistent**. Basic research provides consistent **preclinical** findings on **local vasodilation** and **metabolic activation**, well documented in animal models and in vitro studies. Human clinical studies, however, are **methodologically heterogeneous**: some use objective measurement techniques such as **thermography** or **laser Doppler flowmetry**, while others rely on subjective parameters or small sample sizes. Observational studies and case reports form the majority of clinical works—randomised

controlled trials (RCTs) are still lacking. Moreover, application protocols vary widely (duration, CO₂ concentration, temperature), complicating comparisons. The **safety** of the procedure is well established, though isolated reports describe **risks with improper use** (e.g., CO₂ intoxication).

Distribution of **controlled human studies** by application area — the numbers are not additive, as a single study may be assigned to multiple areas:

CLAIM	EVIDENCE BASE
CO ₂ baths lower blood pressure in hypertension	A few older studies report a slight reduction in blood pressure, but the methodological quality is weak. Controlled trials are still pending.
CO ₂ baths accelerate wound healing	Established: Case reports document positive effects, but no controlled studies have established a causal relationship.
CO ₂ baths have systemic effects on metabolism	Basic research demonstrates only local effects on microcirculation. Systemic effects have not been investigated.
CO ₂ baths are an alternative to drug therapies in PAOD	Studies show an improvement in blood circulation, but there are no data on clinical outcomes (e.g., walking distance, pain reduction).

5. The Most Robust Studies

Ranked by evidence strength, not prominence. The full evaluation includes significantly more studies; here, the most reliable are highlighted.

Observational Human Studies

- ¹ The Effect of Dry Carbon Dioxide Bathing on Peripheral Blood Circulation Measured by Thermal Imaging among Patients with Risk Factors of PAD (2021)
- ² Functional and cosmetic reconstruction of palmar heat press injury following wound bed preparation combined with artificial highly concentrated ... (2023)
- ³ [Reaction of the autonomic nervous system to carbon dioxide baths in patients with cardiovascular diseases] (2009)
- ⁴ Epidemiologic and Molecular Investigation of a MRSA Outbreak Caused by a Contaminated Bathtub for Carbon Dioxide Hydrotherapy and Review of the ... (2020)

6. Summary

What is established: The local promotion of blood circulation through carbon dioxide baths is well documented by basic research and clinical observations. Studies show an increase in skin blood flow due to vasodilation, triggered by a decrease in tissue pH and the release of nitric oxide (NO). Thermographic measurements and laser Doppler flowmetry consistently confirm this effect in observational

settings. Moreover, the safety of the procedure under proper application in controlled settings (e.g., health resorts) is well established, with hygienic risks minimised through standardised protocols. Epidemiological investigations highlight the importance of disinfection measures to prevent nosocomial infections such as MRSA outbreaks.

What is plausible and what might follow: **Plausible:** The observed effects on peripheral blood flow and wound healing are biologically plausible and could be therapeutically relevant, particularly in early stages of peripheral arterial occlusive disease (PAOD) or chronic wounds. **Hypothesis:** The thermographically detected temperature changes could indicate increased microcirculation, which may positively affect tissue oxygenation and nutrient supply. However, long-term data are lacking to show whether these effects are sustained or translate into patient-relevant outcomes such as pain reduction or functional improvement. Changes in heart rate variability suggest a possible stress-reducing or relaxing effect, similar to other balneological procedures. If CO₂ baths are confirmed to promote parasympathetic activation, this could be therapeutically relevant in conditions with sympathetic overactivity (e.g., hypertension). However, targeted studies are lacking to test this hypothesis or examine clinical endpoints such as blood pressure reduction.

What a study would need to clarify: To comprehensively assess the therapeutic potential of carbon dioxide baths, randomised controlled trials (RCTs) are required that systematically investigate the effects in specific indications (e.g., PAOD, wound healing, hypertension). These studies should use standardised application protocols (duration, CO₂ concentration, temperature) and assess patient-relevant outcomes such as pain reduction, functional improvement, or blood pressure reduction. It would also be important to document long-term effects to determine whether the observed acute effects are sustained. Comparing CO₂ baths with established hyperaemic procedures (e.g., physical therapies) could clarify whether CO₂ baths offer specific advantages. Finally, studies should specifically examine the systemic effects of CO₂ baths to determine whether the method influences metabolism or the cardiovascular system beyond local effects. Hygienic aspects, particularly in hydrotherapy applications, should be addressed through standardised protocols to prevent nosocomial infections.

7. What Remains Open

- **Long-term effects:** How long does the improved microcirculation persist after a CO₂ bath? Are there cumulative effects with repeated application?
- **Clinical relevance:** Does the local promotion of blood flow translate into measurable improvements in PAOD, wound healing, or hypertension?
- **Standardisation:** What CO₂ concentration, bath duration, and temperature are optimal for specific applications?

Frequently Asked Questions

Can a CO₂ bath help with peripheral arterial occlusive disease (PAOD)?

Plausible: Studies show that CO₂ baths significantly increase **skin blood flow** in treated areas. This could theoretically alleviate PAOD symptoms, for example by improving tissue oxygen supply. However, **no controlled studies** have demonstrated a clinical effect (e.g., prolonged pain-free walking distance). Existing data come from observational studies or case reports that do not allow causal conclusions. A systematic evaluation in randomised trials is still pending.

Are there risks associated with CO₂ baths?

Proven: When applied correctly, CO₂ baths are safe. The CO₂ is absorbed through the skin and not inhaled, so systemic effects such as **hypercapnia** (elevated blood CO₂ levels) are excluded. However, **individual case reports** describe complications from improper use, for example if high concentrations of CO₂ gas are inhaled. One documented case describes a **fatal incident** due to CO₂ intoxication in a therapy bath. Therefore, a **controlled environment** with adequate ventilation and monitoring of CO₂ concentration is essential.

How does a dry CO₂ bath differ from a wet one?

Plausible: In a **wet CO₂ bath**, the body is immersed in CO₂-enriched water, whereas in a **dry CO₂ bath** the gas flows around the skin. Both methods induce **local vasodilation**, but the mechanisms differ slightly: in the wet bath, the **hydrostatic pressure** of the water additionally affects blood flow. In the dry bath, this factor is absent, which can facilitate use in patients with **oedema** or **heart failure**. Studies show that both methods increase skin blood flow, but direct comparisons are lacking. The choice depends on the indication and the patient's individual conditions.

Sources

- 1 The Effect of Dry Carbon Dioxide Bathing on Peripheral Blood Circulation Measured by Thermal Imaging among Patients with Risk Factors of PAD
Zbroja H, Kowalski M, Lubkowska A · 2021
- 2 Functional and cosmetic reconstruction of palmar heat press injury following wound bed preparation combined with artificial highly concentrated carbon dioxide bathing: A case report
Hihara M, Takeji K, Mitsui T, Kuro A, Kakudo N · 2023
- 3 [Reaction of the autonomic nervous system to carbon dioxide baths in patients with cardiovascular diseases]
Amiiants Vlu, Bidzhieva ZN, Shidakova FKh, Dzhereshtiev AZ, Samoïlova OG · 2009
- 4 Epidemiologic and Molecular Investigation of a MRSA Outbreak Caused by a Contaminated Bathtub for Carbon Dioxide Hydrotherapy and Review of the Literature
Baier C, Ebadi E, Mett TR, Stoll M, Küther G, Vogt PM et al. · 2020

International Health Research

Research, put in context. Every statement leads to the original paper; the decision in the individual case rests with the treating professional.
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