GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 6 (375) Июнь 2026

ТБИЛИСИ - NEW YORK

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.
GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.
ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ,რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

Содержание:

COGNITIVE IMPAIRMENT AFTER CORONARY ARTERY BYPASS GRAFTING: THE ROLE OF MEDICAL REHABILITATION — A LITERATURE REVIEW

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Abstract.

Introduction: Advances in cardiac surgery, extracorporeal circulation techniques, and perioperative care have significantly improved survival following coronary artery bypass grafting (CABG). However, the increasing number of postoperative survivors has led to a growing burden of long-term complications, among which cognitive impairment represents a major yet underrecognized clinical problem.

Objective: To critically synthesize current evidence on the prevalence, mechanisms, and clinical significance of cognitive impairment after CABG, as well as to evaluate the role of medical rehabilitation in its prevention and management.

Methods: A structured literature search was conducted across PubMed, Scopus, Web of Science, and Google Scholar, focusing on studies published within the last five years. Study selection was performed based on predefined inclusion criteria, and elements of the PRISMA framework were applied to enhance transparency. A total of 55 studies were included in the final analysis.

Results: Postoperative cognitive impairment remains one of the most common neurological complications following CABG, affecting approximately 30–60% of patients in the early postoperative period, with persistent deficits observed in a substantial proportion of cases. Its pathogenesis is multifactorial and involves preoperative vulnerability, intraoperative cerebral hypoperfusion and microembolization, systemic inflammation, and postoperative complications. Despite its clinical relevance, cognitive impairment is frequently underdiagnosed and insufficiently addressed within standard rehabilitation programs.

Conclusions: Current rehabilitation models lack systematic approaches to the assessment and management of cognitive dysfunction after CABG. Integrative strategies combining cognitive training, physical rehabilitation, and multimodal interventions demonstrate promising potential for improving cognitive outcomes and quality of life. Further high-quality studies are required to develop standardized rehabilitation protocols with mandatory inclusion of cognitive endpoints.

Key words. Cognitive impairment, coronary artery bypass grafting, cardiac rehabilitation, neurocognitive disorders.

Introduction.

Coronary artery bypass grafting (CABG) remains a cornerstone of myocardial revascularization in patients with coronary artery disease and is associated with improved survival and long-term prognosis. However, as postoperative survival continues to increase, greater attention is being directed toward long-term complications that significantly affect functional outcomes and quality of life. Among these, postoperative cognitive impairment has emerged as a clinically important yet insufficiently addressed condition. Cognitive decline following CABG is characterized by impairments in memory, attention, processing speed, and executive functioning, which may adversely affect patients' rehabilitation potential, treatment adherence, and social reintegration. Despite advances in surgical techniques, anesthetic management, and perioperative monitoring, the reported incidence of cognitive impairment remains substantial and highly variable across studies. Current evidence suggests that postoperative cognitive dysfunction is a multifactorial phenomenon involving a complex interplay of preoperative vulnerability, intraoperative factors such as cerebral hypoperfusion and microembolization, and postoperative complications including systemic inflammation and hypoxia. However, the relative contribution of these factors remains incompletely understood, and findings across studies are often inconsistent. Importantly, despite the growing body of literature on postoperative cognitive impairment, there remains a lack of standardized approaches to its diagnosis, monitoring, and rehabilitation. In particular, cognitive outcomes are frequently underrepresented in cardiac rehabilitation programs, which continue to focus predominantly on physical recovery. In this context, there is a critical need to integrate current evidence on the mechanisms, risk factors, and clinical consequences of cognitive impairment after CABG with emerging data on rehabilitation strategies aimed at improving neurocognitive outcomes. The aim of this review is to critically evaluate and synthesize contemporary literature on cognitive impairment after CABG, with a particular focus on its pathophysiology, diagnostic challenges, and the role of medical rehabilitation in optimizing patient outcomes.

Search Strategy.

This review was conducted as a scoping literature review aimed at synthesizing contemporary evidence regarding cognitive impairment and rehabilitation strategies following coronary artery bypass grafting (CABG). The review methodology was informed by elements of the PRISMA Extension for Scoping Reviews (PRISMA-ScR) to improve transparency of study identification and selection. A structured literature search was performed in PubMed, Scopus, Web of Science, and Google Scholar for studies published between January 2020 and February 2026. Both Medical Subject Headings (MeSH) and free-text terms were used. The primary search strategy included combinations of the following keywords and MeSH terms: ("coronary artery bypass grafting" OR "CABG") AND ("cognitive impairment" OR "postoperative cognitive dysfunction" OR "perioperative neurocognitive disorders" OR "POCD") AND ("cardiac rehabilitation" OR "medical rehabilitation" OR "cognitive rehabilitation" OR "exercise therapy"). An example of the PubMed search strategy was as follows: (("Coronary Artery Bypass"[Mesh] OR CABG OR "coronary artery bypass grafting") AND ("Cognitive Dysfunction"[Mesh] OR "cognitive impairment" OR "postoperative cognitive dysfunction" OR "perioperative neurocognitive disorders" OR POCD) AND ("Rehabilitation"[Mesh] OR "cardiac rehabilitation" OR "cognitive rehabilitation" OR "exercise therapy" OR "physical rehabilitation")) Additional manual screening of reference lists from relevant articles and recent reviews was also performed to identify potentially eligible studies. The inclusion criteria comprised peer-reviewed full-text articles published in English or Russian that evaluated cognitive outcomes, neurocognitive disorders, or rehabilitation interventions in adult patients undergoing CABG. Randomized controlled trials, cohort studies, observational studies, systematic reviews, and meta-analyses were considered eligible. Conference abstracts, editorials, duplicate publications, non-peer-reviewed sources, and studies lacking clearly defined cognitive or rehabilitation outcomes were excluded. Study selection was independently performed by two reviewers. After removal of duplicates and screening of titles and abstracts, full-text articles were assessed for eligibility. Disagreements between reviewers were resolved through discussion and consensus. A total of 742 records were initially identified across the databases. After duplicate removal and title/abstract screening, 107 full-text articles were assessed for eligibility. Following application of predefined inclusion and exclusion criteria, 55 studies were included in the final qualitative synthesis.

The PRISMA-ScR flow diagram illustrating the study selection process is presented in Figure 1.

Quality of Evidence and Methodological Considerations.

The included studies demonstrated substantial methodological heterogeneity with respect to study design, sample size, cognitive assessment tools, rehabilitation protocols, and follow-up duration. Randomized controlled trials generally provided higher-quality evidence regarding rehabilitation interventions, whereas observational studies were more susceptible to selection bias and confounding factors. Systematic reviews and meta-analyses were considered the highest level of evidence included in this review. Because of the heterogeneity of study methodologies and reported outcomes, a formal quantitative meta-analytic risk-of-bias assessment had limited applicability. Nevertheless, methodological quality and clinical relevance were critically appraised using domains commonly applied in Cochrane and GRADE-based approaches, including assessment of study limitations, selection bias, heterogeneity of interventions, variability of cognitive outcome measures, and consistency of follow-up reporting.

Cognitive Impairment After Coronary Artery Bypass Grafting.

Concept and Terminology of Postoperative Cognitive Impairment:

In contemporary cardiac surgery, postoperative cognitive impairment—commonly referred to as postoperative cognitive dysfunction (POCD)—is recognized as one of the most significant neurological complications following myocardial revascularization procedures, including coronary artery bypass grafting (CABG). POCD encompasses a spectrum of higher-order cognitive deficits, including impairments in memory, attention, processing speed, executive function, and psychomotor performance, occurring in both early and late postoperative periods [1-3]. In contrast to postoperative delirium, which is characterized by an acute onset, a fluctuating course, and disturbances of consciousness, POCD typically presents with more subtle clinical manifestations and is often detectable only through targeted neuropsychological assessment [2]. Evidence suggests that POCD may be transient or persist for months or even years, significantly affecting patients' functional independence and quality of life [3]. Importantly, contemporary conceptual frameworks emphasize that postoperative cognitive impairment should not be considered an isolated consequence of surgical intervention, but rather the result of a complex interaction between patient-related vulnerability and procedure-related factors [4]. Terminological heterogeneity remains a major methodological challenge in this field. Terms such as "postoperative cognitive decline," "postoperative cognitive dysfunction," and "neurocognitive disorders after cardiac surgery" are often used interchangeably, thereby limiting comparability across studies [2]. More recently, the broader concept of "perioperative neurocognitive disorders" has been proposed, encompassing both acute and delayed cognitive impairments; however, its implementation in clinical research remains inconsistent [2]. In 2018, the Nomenclature Consensus Working Group recommended replacing the traditional term "postoperative cognitive dysfunction (POCD)" with the broader concept of "perioperative neurocognitive disorders" (PND), encompassing both acute and delayed cognitive impairments associated with surgical procedures and anesthesia. This terminology aligns postoperative cognitive changes with contemporary neurocognitive disorder classifications and emphasizes the multifactorial nature of perioperative brain dysfunction. Nevertheless, the term POCD continues to be widely used in cardiac surgery literature; therefore, both terms are referenced throughout the present review where appropriate. Notably, data from large population-based studies indicate that long-term cognitive trajectories in elderly patients following coronary revascularization are primarily determined by baseline cognitive status and age, rather than by the type of surgical intervention alone [5].

Prevalence of Cognitive Impairment After Coronary Artery Bypass Grafting:

The prevalence of cognitive impairment following coronary artery bypass grafting (CABG) remains substantial despite advances in surgical and anesthetic techniques. According to large systematic reviews and meta-analyses, postoperative cognitive dysfunction occurs in approximately 30–60% of patients in the early postoperative period, with a proportion of cases persisting during long-term follow-up [6]. Similarly, during the inpatient rehabilitation phase, cognitive deficits of varying severity have been reported in 32–77% of patients after CABG, with mild-to-moderate impairments predominating [7]. Notably, these forms are frequently underrecognized in routine clinical practice. However, findings across studies remain inconsistent. Some prospective investigations report substantially lower incidence rates of postoperative cognitive dysfunction under optimized perioperative conditions. For

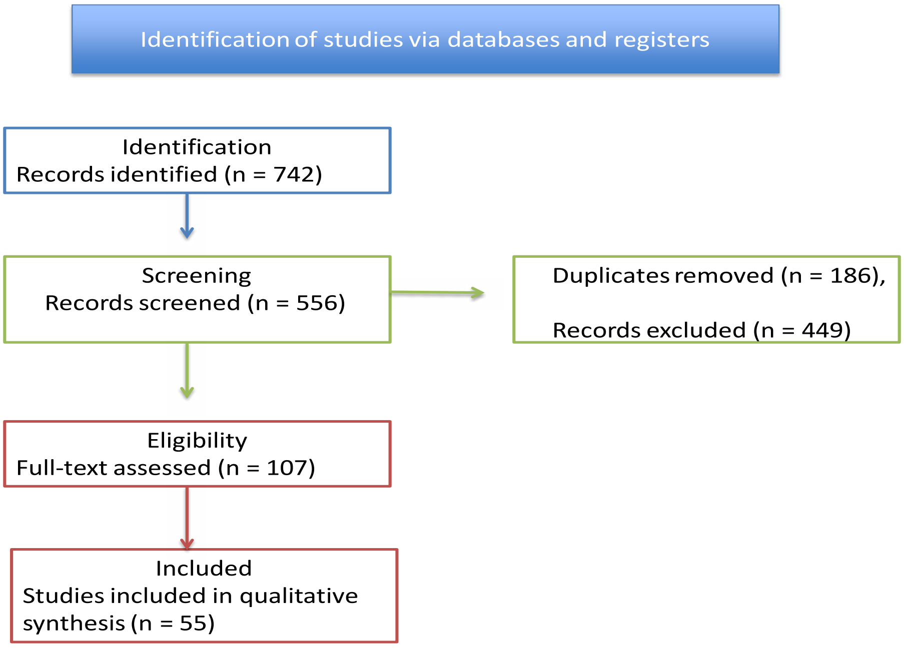

Figure 1. *The PRISMA-ScR flow diagram illustrating the study selection process.*

Table 1. *FITT Principles of Rehabilitation Interventions After CABG Associated with Cognitive and Functional Benefits.*

Intervention	Frequency	Intensity	Time	Type	Reported Benefits
Aerobic exercise training	3–5 sessions/week	Moderate intensity	30–45 min/session	Walking, treadmill, cycling	Improved functional capacity, cerebral perfusion, cognitive performance
Combined cardiac rehabilitation	3–5 sessions/week	Moderate	8–12 weeks	Aerobic + resistance training	Improved quality of life, reduced cardiovascular risk, better rehabilitation adherence
Prehabilitation	2–5 sessions/week before surgery	Low-to-moderate	2–4 weeks preoperatively	Aerobic exercise and conditioning	Reduced risk of POCD, enhanced neurovascular resilience
Cognitive training	Daily or 3–5 sessions/week	Structured cognitive load	20–40 min/session	Memory, attention, executive-function exercises	Improved attention, executive functioning, cognitive reserve
Dual-task cognitive rehabilitation	3–5 sessions/week	Moderate	20–30 min/session	Simultaneous postural and cognitive tasks	Enhanced neuroplasticity and executive function
Inspiratory muscle training	5–7 sessions/week	Moderate inspiratory resistance	15–30 min/session	Respiratory muscle exercises	Improved oxygenation, exercise tolerance, recovery
Neuromuscular electrical stimulation	Daily or several times/week	Low-to-moderate	20–30 min/session	Quadriceps electrical stimulation	Improved mobility and physical recovery in early rehabilitation

instance, Rahman et al. (2024) reported no cases of POCD at 6 weeks and 3 months following elective CABG when strict intraoperative monitoring protocols were implemented [1]. These findings were attributed to younger patient age, higher educational level, absence of neurological comorbidities, and the use of advanced cerebral oxygenation monitoring techniques. In a prospective comparative study by Relander et al., cognitive trajectories were assessed in patients undergoing CABG and carotid endarterectomy. POCD was more frequently observed in the early postoperative period after CABG; however, cognitive function demonstrated partial recovery during the stable phase at 3 months [8]. Taken together, these findings highlight the heterogeneous and potentially reversible nature of postoperative cognitive impairment in a subset of patients. Overall, the substantial variability in reported prevalence rates is likely explained by differences in study design, cognitive assessment methods, follow-up duration, and baseline patient characteristics [1,3,4].

Risk Factors for Cognitive Impairment:

The development of postoperative cognitive impairment following coronary artery bypass grafting (CABG) is widely recognized as a multifactorial process involving preoperative, intraoperative, and postoperative determinants [4,5,9]. Evidence from large-scale systematic reviews and meta-analyses highlights the complexity of these interactions. In particular, Greaves et al., in a meta-analysis including more than 60,000 patients, identified advanced age, depression, baseline cognitive impairment, and prior stroke as key preoperative risk factors. Intraoperative and postoperative contributors included prolonged intubation, arrhythmias, and extended intensive care unit stay. Notably, higher baseline cognitive function was found to exert a protective effect [10]. Importantly, while many of these risk factors are non-modifiable, preoperative psychoemotional and cognitive disturbances may be amenable to intervention, thereby providing opportunities for targeted rehabilitation strategies. Findings from large cohort studies further emphasize the dominant role of patient-related characteristics in determining cognitive outcomes. In a study by Whitlock et al., long-term memory decline was not independently associated with the type of revascularization procedure but was instead primarily driven by age and baseline cognitive status [5]. These findings challenge the traditional assumption that surgical technique is a primary determinant of postoperative cognitive decline. Subsequent analyses have reinforced the importance of considering baseline characteristics, comorbidities, and trajectories of cognitive aging when interpreting postoperative cognitive outcomes, rather than relying solely on comparisons between surgical and endovascular interventions [11]. Preoperative risk factors include advanced age, diabetes mellitus, arterial hypertension, depression, baseline cognitive impairment, and reduced physical activity [12]. In addition, observational data suggest that obesity, physical inactivity, and a family history of cardiovascular disease may be associated with unfavorable cognitive trajectories in elderly patients [13]. Intraoperative factors include the duration of surgery, cardiopulmonary bypass time, embolic events, episodes of hypotension, and cerebral hypoxia [2]. Emerging evidence suggests that the use of intraoperative neuromonitoring techniques—such as near-infrared spectroscopy and depth of anesthesia monitoring—may reduce the risk of cognitive complications by enabling timely detection and correction of cerebral hypoperfusion [1]. Postoperative contributors include delirium, infectious complications, arrhythmias, and insufficient engagement in early rehabilitation [2,7]. In particular, physical inactivity and the absence of structured rehabilitation programs in the early recovery period may exacerbate cognitive decline [7,14]. Overall, accumulating evidence indicates that the type of revascularization procedure is not a primary determinant of long-term cognitive outcomes, underscoring the need to shift the clinical focus toward comprehensive postoperative management and rehabilitation strategies [5]. In recent years, increasing attention has been paid to depression as both a risk factor and a modifier of cognitive outcomes after CABG. In a randomized study by Lewis et al., preoperative depression was not associated with the development of POCD; however, postoperative depressive symptoms were linked to significantly worse performance across multiple cognitive domains, including attention, memory, processing speed, and executive function, as well as reduced quality of life. Complementary findings from observational studies suggest that depression prior to CABG may be associated with cognitive and functional impairments consistent with the concept of "vascular depression," potentially reflecting underlying microangiopathy and white matter damage. Taken together, these findings highlight the complex and heterogeneous role of depression in postoperative cognitive outcomes and underscore the importance of its systematic assessment in both preoperative and postoperative settings to enable early intervention and individualized rehabilitation strategies [15,16].

Clinical and Social Significance of POCD:

Cognitive impairment following coronary artery bypass grafting (CABG) has a substantial impact on patients' daily functioning, social adaptation, and treatment adherence. Although some studies have not demonstrated a direct association between postoperative cognitive dysfunction (POCD) and reduced quality of life at 6 months postoperatively [3], other evidence suggests that persistent cognitive impairment is associated with poorer functional status and delayed rehabilitation [2,7]. Prospective data indicate that, in elderly patients undergoing CABG, physical function may improve over time, whereas cognitive decline may follow a more progressive and persistent trajectory, underscoring the clinical relevance of POCD [17]. Given the aging population of patients undergoing CABG, postoperative cognitive impairment represents an increasingly important clinical challenge that requires a comprehensive approach, including not only preventive strategies but also active and targeted rehabilitation interventions.

Assessment and Diagnosis of Cognitive Impairment After Coronary Artery Bypass Grafting.

Relevance and Challenges in the Diagnosis of Cognitive Impairment:

Cognitive impairment following coronary artery bypass grafting (CABG) is characterized by considerable clinical heterogeneity and is frequently underrecognized in the absence of standardized diagnostic algorithms. Variability in reported prevalence rates of postoperative cognitive dysfunction (POCD) is largely attributable to differences in diagnostic approaches, timing of assessment, and the heterogeneity of cognitive evaluation tools used across studies [18,19]. Moreover, inconsistencies in diagnostic criteria and the lack of standardized assessment protocols limit the comparability of findings and hinder the development of a robust evidence base [18]. In this context, there is a growing need for a comprehensive and multidimensional approach to the diagnosis of POCD, integrating clinical, neuropsychological, and instrumental methods [3,20,21].

Neuropsychological Testing and Timing of Assessment:

Neuropsychological testing remains the cornerstone for detecting cognitive impairment following coronary artery bypass grafting (CABG). Commonly used screening tools include the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE), as well as comprehensive test batteries designed to evaluate attention, memory, and executive function [3,7,13,22]. Importantly, the timing of cognitive assessment plays a critical role in the interpretation of results. Early postoperative testing may reflect transient cognitive changes associated with anesthesia, surgical stress, and acute physiological disturbances, whereas delayed assessment allows for the identification of persistent forms of postoperative cognitive dysfunction (POCD) [19,23]. Notably, early cognitive changes may also have prognostic value, as they have been shown to predict long-term adverse neurocognitive outcomes [23,24].

Limitations of Neuropsychological Methods and the Influence of Confounding Factors:

Despite their high clinical relevance, neuropsychological assessments are influenced by a number of non-medical factors, including educational level, psychoemotional status, patient motivation, and the presence of anxiety and depressive disorders [12,13,25]. It has been shown that individual psychological characteristics, such as alexithymia and heightened anxiety, may distort the results of cognitive evaluation and lead to both overestimation and underestimation of POCD [5,20]. In addition, the lack of adjustment for cognitive reserve and educational level reduces the accuracy of data interpretation [26,27].

Neurophysiological Methods and Electroencephalography:

Electroencephalography (EEG) is increasingly recognized as a promising objective tool for assessing brain function following coronary artery bypass grafting (CABG). Alterations in EEG spectral characteristics, including increased theta activity and reduced alpha power, have been associated with postoperative cognitive decline [6,27-29]. Importantly, EEG has been shown to detect functional brain abnormalities even in the absence of overt clinical manifestations of postoperative cognitive dysfunction (POCD), highlighting its value for early diagnosis and monitoring of cognitive changes [20,27]. The potential of EEG to predict postoperative neurocognitive complications is further supported by data from ongoing protocol-based studies. In particular, the DIVULGE study (Delirium VULnerability in GEriatrics) aims to evaluate preoperative EEG markers in elderly patients undergoing CABG and to correlate neurophysiological parameters with the development of postoperative delirium. It is hypothesized that specific features of EEG spectral power and evoked potentials reflect central nervous system vulnerability and may serve as objective predictors of postoperative neurocognitive disorders, thereby enabling early risk stratification and the personalization of preventive and rehabilitative strategies [30]. Taken together, these findings support the role of EEG as a valuable component of integrated diagnostic models for postoperative cognitive dysfunction [20,27].

Intraoperative Factors and Monitoring of Cognitive Risk:

The assessment of cognitive impairment following coronary artery bypass grafting (CABG) is closely linked to intraoperative risk factors. Monitoring of cerebral oxygenation using near-infrared spectroscopy (NIRS), as well as depth of anesthesia monitoring, enables the detection of episodes of cerebral hypoperfusion and may reduce the risk of postoperative neurocognitive complications [1,2,31]. Several studies have demonstrated that intraoperative episodes of cerebral desaturation are associated with an increased risk of postoperative cognitive dysfunction (POCD) in both early and late postoperative periods [23,24]. Taken together, these findings support the integration of intraoperative parameters into the assessment and prediction of postoperative cognitive outcomes [18,20].

Opportunities for Medical Rehabilitation in Cognitive Impairment After Coronary Artery Bypass Grafting.

Rehabilitation as a Neuroprotective Strategy:

Contemporary perspectives on postoperative cognitive impairment following coronary artery bypass grafting (CABG) are increasingly shifting from viewing it as an inevitable complication to considering it a potentially modifiable condition. A growing body of evidence suggests that the severity and duration of cognitive decline after CABG are determined not only by intraoperative factors but also by the organization of postoperative care and rehabilitation [1-3]. In this context, medical rehabilitation is increasingly recognized as a comprehensive, multimodal intervention encompassing physical activity, cognitive stimulation, respiratory training, and psychosocial support, with the potential to influence both functional and cognitive outcomes after surgery [7,14,32,33]. The pathophysiological basis of the neuroprotective role of rehabilitation has been highlighted in recent studies examining the relationship between coronary artery disease, acute myocardial infarction, and cognitive impairment. In a review by Thong et al., chronic cerebral hypoperfusion, neurovascular dysfunction, neuroinflammation, and reduced cognitive reserve were identified as key mechanisms underlying cognitive decline in patients with coronary pathology and following revascularization procedures. Importantly, the authors emphasize that pharmacological therapy and cardiac rehabilitation may mitigate the risk of cognitive impairment by improving systemic and cerebral perfusion, modulating inflammatory responses, and enhancing neuroplasticity, thereby reinforcing the concept of rehabilitation as a neuroprotective strategy [34]. Rehabilitation interventions directly target key pathophysiological mechanisms of postoperative cognitive dysfunction, including neuroinflammation, hypoperfusion, impaired neuroplasticity, and depletion of cognitive reserve [28,35,36]. The effectiveness of cardiac rehabilitation programs following myocardial revascularization has been consistently demonstrated in systematic reviews and meta-analyses. For example, Campos et al. reported that exercise-based cardiac rehabilitation significantly improves physical capacity in patients after CABG and percutaneous coronary intervention, with the greatest benefits observed in aerobic and combined training programs lasting 8–12 weeks [37]. Taken together, these findings support the concept of rehabilitation as a key therapeutic strategy not only for functional recovery but also for the prevention and mitigation of cognitive decline after CABG.

Physical Rehabilitation and Prehabilitation:

Physical activity is one of the most extensively studied components of rehabilitation following coronary artery bypass grafting (CABG). Evidence from systematic reviews and clinical studies demonstrates that regular exercise training improves hemodynamic parameters, functional capacity, and quality of life in these patients [32]. An increasing body of evidence also indicates a significant association between physical activity and cognitive outcomes. During the inpatient rehabilitation phase, structured exercise programs have been associated with improvements in cognitive status and a reduced prevalence of moderate cognitive impairment [38]. Evidence suggests that additional cycle ergometer training is associated with greater improvements in cognitive performance, as assessed by the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE), compared to standard therapeutic exercise programs [9]. In recent years, growing attention has been paid to the concept of prehabilitation. Short-term preoperative aerobic training programs prior to CABG have been shown to reduce the incidence of postoperative cognitive dysfunction and enhance cerebral resilience to ischemic injury [1,28]. These effects are thought to be mediated by activation of neuroplastic mechanisms, increased levels of brain-derived neurotrophic factor (BDNF), and improved neurovascular coupling [28,39,29]. Randomized studies further indicate that early mobilization and active physiotherapy interventions following CABG contribute to improved autonomic regulation and reduced hospital length of stay [40]. Given the limited tolerance to intensive physical activity in the early postoperative period, increasing attention has been directed toward passive or assisted muscle stimulation techniques. In a randomized controlled trial by Rengo et al., the use of neuromuscular electrical stimulation during the first four weeks after hospital discharge—prior to the initiation of phase II cardiac rehabilitation—was associated with accelerated recovery of physical function. Specifically, stimulation of the quadriceps muscles resulted in a greater increase in the distance covered during the 6-minute walk test compared to standard care [41]. Additional real-world evidence is provided by an observational study by Rouleau et al. [42], which demonstrated that completion of a prehabilitation program was associated with higher rates of referral, enrollment, and adherence to cardiac rehabilitation, as well as improvements in cardiorespiratory fitness, body mass index, and reductions in anxiety and depressive symptoms. The authors conclude that prehabilitation is a feasible strategy that may improve postoperative and psychoemotional outcomes, although further high-quality clinical studies are required to determine optimal program design and improve patient adherence [43].

Cardiac Rehabilitation and Quality of Life:

Cardiac rehabilitation following coronary artery bypass grafting (CABG) has traditionally been regarded as a strategy for improving physical capacity and providing secondary prevention of cardiovascular events. However, contemporary evidence suggests a broader impact, including effects on psychoemotional status and health-related quality of life [3,32,33]. Recent studies demonstrate the effectiveness of integrating cognitive and physical components into cardiac rehabilitation programs for patients after CABG. In a randomized controlled trial, multitask cognitive training in the early postoperative period resulted in significant improvements in attention, executive function, and short-term memory, outperforming both standard postoperative care and less complex cognitive training protocols. Notably, the greatest effects were observed when cognitive tasks were combined with postural load, highlighting the potential of multimodal rehabilitation approaches [44]. At the same time, evidence from large-scale meta-analyses confirms the central role of physical activity in secondary prevention and rehabilitation of patients with coronary artery disease, including those undergoing CABG. An updated meta-analysis published in the European Heart Journal, including more than 23,000 patients across 85 randomized controlled trials, demonstrated that exercise-based cardiac rehabilitation is associated with reduced cardiovascular mortality, lower rates of recurrent myocardial infarction and hospitalization, as well as improvements in quality of life and cost-effectiveness [45]. These findings are supported by an updated Cochrane systematic review, which demonstrated that participation in cardiac rehabilitation programs—either exercise-based alone or combined with psychosocial and educational components—reduces myocardial infarction risk, decreases hospitalizations, and improves quality of life in both the short and long term, regardless of revascularization strategy or patient characteristics [46]. Taken together, the available evidence supports a shift from predominantly exercise-focused cardiac rehabilitation toward integrative models that combine physical training with cognitive interventions, which may be particularly relevant for elderly patients and individuals at increased risk of postoperative cognitive impairment. Furthermore, a systematic review by Subih et al. demonstrated that various formats of cardiac rehabilitation—including center-based, home-based, and remote programs—are associated with sustained improvements in quality of life and functional capacity in patients after CABG [14]. However, their impact on cognitive outcomes remains variable, potentially due to the absence of structured cognitive components in some programs. Interestingly, several studies have reported a discrepancy between objective cognitive outcomes and patients' subjective assessments of quality of life. For example, Blokzijl et al. showed that persistent postoperative cognitive dysfunction at 6 months after CABG is not consistently associated with reduced quality of life [3]. At the same time, emerging evidence suggests that cognitive impairment may indirectly influence adherence to rehabilitation and participation in physical activity programs, particularly among older patients [31,47].

Cognitive Training:

Cognitive rehabilitation is increasingly recognized as a promising strategy for the management of postoperative neurocognitive disorders. In recent years, randomized controlled trials have provided growing evidence supporting the effectiveness of cognitive training in preventing postoperative neurocognitive complications. In a multicenter randomized trial by Jiang et al., preoperative cognitive training in patients scheduled for coronary artery bypass grafting (CABG) was associated with a statistically significant reduction in the incidence of postoperative delirium. Specifically, the risk of delirium was reduced by 57% compared to standard care, accompanied by a decrease in both the severity and duration of delirium episodes [48]. These findings suggest that enhancement of cognitive reserve prior to surgery is feasible and support the inclusion of cognitive training within prehabilitation programs for patients undergoing CABG. Cognitive training interventions are designed to stimulate neuroplasticity, compensate for deficits in attention, memory, and executive function, and enhance cognitive reserve [2,49,50]. Randomized studies further demonstrate that postoperative cognitive training can improve specific cognitive domains and exert a positive impact on long-term quality of life [2,49]. In particular, 12-month follow-up data indicate sustained improvements in both physical and mental health components among patients undergoing cognitive rehabilitation after cardiac surgery [2]. However, isolated cognitive training does not consistently lead to a reduction in the incidence of postoperative cognitive dysfunction, highlighting the need for its integration with physical rehabilitation and other non-pharmacological interventions [3,31,33]. Taken together, these findings support a multimodal approach in which cognitive training is combined with other rehabilitation strategies to optimize neurocognitive and functional outcomes after CABG.

Respiratory Training and Adjunctive Methods:

In recent years, increasing attention has been given to respiratory training as a component of comprehensive rehabilitation following coronary artery bypass grafting (CABG). A meta-analysis by Zhang et al. demonstrated that respiratory muscle training improves pulmonary function, reduces postoperative complications, and shortens hospital length of stay [35]. Although cognitive outcomes were not primary endpoints in these studies, improvements in oxygenation and functional status may indirectly contribute to a reduced risk of cognitive impairment [1,2]. Additional attention has been directed toward neuromuscular electrical stimulation and combined rehabilitation approaches aimed at activating both peripheral and central recovery mechanisms. Emerging evidence suggests that such interventions may also exert beneficial effects on cognitive and neurophysiological outcomes after CABG [6,29,32]. In a systematic review and meta-analysis by Araújo et al. (2024), inspiratory muscle training (IMT) was associated with significant improvements in exercise tolerance (as measured by the 6-minute walk test), respiratory muscle strength, hospital length of stay, and quality of life in patients undergoing phase I and II cardiac rehabilitation. Importantly, no adverse events were reported, and beneficial effects were observed at both early and outpatient stages, underscoring the safety and clinical relevance of incorporating respiratory training into rehabilitation programs after CABG [51]. In a randomized controlled trial by Rengo et al., the use of neuromuscular electrical stimulation in the early postoperative period—between hospital discharge and the initiation of phase II cardiac rehabilitation—was associated with faster recovery of physical function. Specifically, quadriceps stimulation over a 4-week period resulted in a significant increase in the distance covered during the 6-minute walk test and improved exercise capacity compared to standard care [32]. Randomized studies further demonstrate that the incorporation of respiratory and adjunctive exercises into early cardiac rehabilitation improves functional capacity, reduces pain, and enhances daily activity levels. Respiratory muscle training contributes to increased walking distance and improved vascular function, while the addition of core and upper limb exercises promotes sternal healing and overall functional recovery [52,53].

The available evidence suggests that multimodal rehabilitation strategies combining physical exercise, cognitive training, and respiratory interventions may provide the greatest benefit for both functional and neurocognitive recovery after CABG. However, substantial heterogeneity in intervention protocols and outcome assessment highlights the need for standardized rehabilitation models and randomized controlled trials with cognitive endpoints.

Barriers and Future Directions in the Implementation of Rehabilitation Programs:

Despite the proven effectiveness of rehabilitation interventions, their implementation in clinical practice remains challenging. Key barriers include low patient adherence, logistical constraints, and socioeconomic factors [33,54]. Prospective data indicate particularly low participation rates among elderly patients in cardiac rehabilitation programs, with cognitive impairment and adverse social determinants representing significant obstacles to engagement [55]. Furthermore, qualitative studies highlight the importance of individualized approaches, family support, and the use of remote or tele-rehabilitation modalities to improve patient participation and adherence [14,54]. Taken together, these findings underscore the need for patient-centered and flexible rehabilitation models tailored to individual clinical and social contexts.

Conclusion.

The present analysis of contemporary literature demonstrates the high prevalence of cognitive impairment in patients following coronary artery bypass grafting (CABG) and confirms its significant clinical and social impact within the spectrum of postoperative complications. Despite substantial advances in cardiac surgery, anesthesiology, and perioperative monitoring, postoperative cognitive dysfunction remains a relevant clinical problem, affecting quality of life, functional independence, and patients' rehabilitation potential. The available evidence reveals marked heterogeneity in the reported prevalence and structure of cognitive impairment after CABG, which is largely attributable to differences in diagnostic approaches, timing of neuropsychological assessment, and applied criteria. The lack of standardized diagnostic protocols limits the comparability of study findings and highlights the need for the standardization of cognitive assessment methods in both perioperative and postoperative settings. Contemporary studies confirm the multifactorial nature of the pathogenesis of cognitive impairment after CABG, involving preoperative patient characteristics, intraoperative risk factors, and postoperative management. In this context, a comprehensive diagnostic approach that integrates neuropsychological testing, neurophysiological methods, and biomarkers of neuroinjury and neuroplasticity is of particular importance, as it enables more accurate risk stratification and objective evaluation of recovery dynamics. Editorial and large-scale studies emphasize that the key determinant of cognitive outcomes after coronary revascularization is not the type of intervention per se, but rather individual patient characteristics, including age, baseline cognitive reserve, and comorbidities, which necessitates a personalized approach to cognitive assessment and rehabilitation. The analysis of the literature also highlights the potential of medical rehabilitation as a key strategy for the prevention and management of cognitive impairment after CABG. Physical rehabilitation, cardiac rehabilitation programs, cognitive training, and respiratory exercises have demonstrated beneficial effects not only on functional status and quality of life but also on cognitive outcomes, particularly when implemented within combined and personalized rehabilitation programs. However, several issues remain unresolved, including the optimal timing of rehabilitation initiation, the selection of intervention components, and the duration of rehabilitation programs, as well as the limited number of randomized studies focusing on cognitive endpoints. This underscores the need for further prospective research aimed at developing standardized and clinically applicable rehabilitation protocols with mandatory assessment of cognitive outcomes. Future research should prioritize the development of standardized multimodal rehabilitation protocols incorporating both physical and cognitive interventions. Particular attention should be given to the selection of validated cognitive endpoints, including instruments such as the Montreal Cognitive Assessment (MoCA), as well as to the integration of neurophysiological and biomarker-based monitoring approaches. Randomized controlled trials with long-term follow-up are needed to determine the optimal timing, intensity, and duration of rehabilitation interventions and to establish clinically effective strategies for preventing and managing perioperative neurocognitive disorders after CABG.

Limitations.

This review has several limitations. First, it is based on studies published within the past five years, which may have resulted in the exclusion of earlier research with potential methodological and clinical relevance. Second, the included studies demonstrate substantial heterogeneity in study design, sample characteristics, diagnostic tools, and timing of cognitive assessments, limiting direct comparability and precluding quantitative synthesis of results. Third, in the majority of studies, cognitive impairment was assessed as a secondary or exploratory outcome rather than a primary endpoint, which affects the strength of evidence regarding the impact of rehabilitation interventions on cognitive recovery. Finally, the number of randomized controlled trials specifically addressing cognitive rehabilitation in patients after CABG remains limited, and data on long-term cognitive outcomes are insufficient. These limitations highlight the need for future prospective studies employing standardized diagnostic criteria, uniform rehabilitation protocols, and mandatory assessment of cognitive endpoints.

Implications.

The findings of this review support the integration of cognitive assessment into standard clinical management algorithms for patients undergoing coronary artery bypass grafting. They further underscore the importance of implementing comprehensive, multimodal rehabilitation strategies aimed at improving long-term cognitive, functional, and social outcomes in this patient population.

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