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Editorial Board Member of *World Journal of Radiology*, Roberto Grassi, MD, Professor, Chief, Department of Radiology, University of Campania Luigi Vanvitelli, Napoli, 80138, Italy. roberto.grassi@unicampania.it

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Innovative approaches beyond periprocedural hydration for preventing contrast-induced acute kidney injury

Chun-Han Cheng, Wen-Rui Hao, Tzu-Hung Cheng

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Chun-Han Cheng, Department of Medical Education, Linkou Chang Gung Memorial Hospital, Taoyuan 33305, Taiwan

Wen-Rui Hao, Division of Cardiology, Department of Internal Medicine, Shuang Ho Hospital, Ministry of Health and Welfare, Taipei Medical University, Taipei 23561, Taiwan

Wen-Rui Hao, Division of Cardiology, Department of Internal Medicine, School of Medicine, College of Medicine, Taipei Medical University, Taipei 11002, Taiwan

Tzu-Hung Cheng, Department of Biochemistry, School of Medicine, College of Medicine, China Medical University, Taichung 404328, Taiwan

Co-corresponding authors: Wen-Rui Hao and Tzu-Hung Cheng.

Corresponding author: Tzu-Hung Cheng, PhD, Professor, Department of Biochemistry, School of Medicine, College of Medicine, China Medical University, No. 91 Xueshi Road, North District, Taichung 404328, Taiwan. thcheng@mail.cmu.edu.tw

Abstract

Contrast-induced acute kidney injury (CI-AKI) is a major concern in clinical practice, particularly among high-risk patients with preexisting renal and cardiovascular conditions. Although periprocedural hydration has long been the primary approach for CI-AKI prevention, recent advancements have led to the development of novel approaches such as RenalGuard and contrast removal systems. This editorial explores these emerging approaches and highlights their potential for enhancing CI-AKI prevention. By incorporating the latest evidence into clinical practice, health-care professionals can more effectively maintain renal function and improve outcomes for patients undergoing contrast-enhanced procedures.

Key Words: Contrast-induced acute kidney injury; Contrast-induced acute kidney injury prevention; Periprocedural hydration; RenalGuard; Contrast removal systems

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Core Tip: Preventing contrast-induced acute kidney injury (CI-AKI) is crucial for patients undergoing contrast-enhanced procedures, particularly those with preexisting renal or cardiovascular conditions. Although periprocedural hydration remains a fundamental preventive measure, emerging approaches such as RenalGuard and contrast removal systems are promising alternatives. Recent research has demonstrated that these innovative approaches have the potential to substantially improve CI-AKI prevention and patient outcomes. Staying updated on these advancements and incorporating them into clinical practice are essential for optimizing renal protection.

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INTRODUCTION

This editorial provides a commentary on the review article “Navigating nephrotoxic waters: A comprehensive overview of contrast-induced acute kidney injury prevention”, authored by Theofilis and Kalaitzidis[1] and published in *World Journal of Radiology*. The review extensively examines strategies for preventing contrast-induced acute kidney injury (CI-AKI). CI-AKI is a major clinical concern and is the third leading cause of acute kidney injury after the administration of contrast media in diagnostic and therapeutic procedures. The pathophysiology of CI-AKI, although not completely elucidated, involves medullary hypoxia and direct nephrotoxicity from contrast agents. Patients with preexisting renal and cardiovascular conditions and patients with critical illnesses are especially vulnerable; they are at increased risk of prolonged hospital stays and elevated mortality rates. The aforementioned review describes the importance of periprocedural hydration as the primary measure for CI-AKI prevention. However, recent advancements have led to the development of approaches that may enhance CI-AKI prevention, particularly for high-risk patients. Among these approaches, RenalGuard and contrast removal systems are prominent innovative options. Studies, including those by Du *et al*[2] and Nardi *et al*[3], have highlighted the potential of these innovations. For example, the RenalGuard system facilitates high-volume urine output, thus aiding in the rapid elimination of contrast media from the kidneys. Moreover, contrast removal systems can effectively reduce the adverse effects of contrast agents on renal function.

EMERGING APPROACHES FOR CI-AKI PREVENTION

The traditional approach to preventing CI-AKI primarily involves periprocedural hydration, which dilutes and eliminates contrast agents, thereby minimizing their nephrotoxic effects. Although this approach is relatively effective, it has limited efficacy, especially in patients at high risk of CI-AKI. Considering these limitations, scholars have recently proposed several innovative approaches that offer enhanced protection against CI-AKI. Recent reviews, including that by Theofilis and Kalaitzidis[1], have highlighted the potential of new interventions, such as the RenalGuard system and contrast removal techniques, for enhanced CI-AKI prevention. The RenalGuard system promotes high-volume urine output, which can facilitate the rapid elimination of contrast media from the kidneys[1]. Additionally, contrast removal systems have been demonstrated to be effective in reducing the renal burden of contrast agents, offering an additional layer of protection for at-risk patients[2]. Other promising approaches involve the use of inorganic nitrates and novel pharmacological agents. For example, the NITRATE-CIN trial demonstrated that inorganic nitrates could mitigate contrast-induced nephropathy in patients undergoing coronary angiography[4]. Similarly, a study revealed that the use of tetramethylpyrazine can attenuate renal tubular epithelial cell ferroptosis, thereby reducing the risk of contrast-induced nephropathy [5]. By staying updated on these emerging approaches and incorporating them into clinical practice, health-care professionals can substantially enhance CI-AKI prevention for their patients.

RENALGUARD SYSTEM

The RenalGuard system is one of the most promising advancements for preventing CI-AKI. By combining hydration and diuretics, this system facilitates controlled diuresis, thereby increasing urine output and enhancing the clearance of contrast media[1]. The RenalGuard system maintains a high urine flow rate, which helps mitigate the nephrotoxic effects of contrast agents[6]. Initial studies have highlighted the efficacy of this system in reducing the incidence of CI-AKI, particularly in high-risk patients such as those with critical illness or preexisting renal and cardiovascular conditions[3,7]. By promoting adequate urine flow, the system can optimize renal function during procedures involving contrast media, thus potentially improving patient outcomes[2]. Incorporating the RenalGuard system into clinical practice represents an advancement in CI-AKI preventive approaches. By adopting such innovative approaches, health-care professionals can mitigate the renal injury risks associated with contrast-enhanced procedures, thus improving patient care[1,6]. Considering these advancements, health-care professionals should stay updated on evolving research on CI-AKI pre-

vention to optimize patient safety and outcomes in clinical settings[8,9].

CONTRAST REMOVAL SYSTEMS

Contrast removal systems are designed to actively eliminate contrast agents from the bloodstream before these agents can cause substantial renal damage[1]. These systems selectively filter contrast media during and immediately after procedures, thereby reducing the renal burden[6]. Clinical trials have demonstrated promising outcomes for contrast removal systems, indicating their effectiveness in decreasing the incidence of CI-AKI, particularly in patients with preexisting renal conditions[3,5]. By facilitating the timely removal of contrast agents, these systems contribute to preserving renal function during contrast-enhanced procedures[2]. Incorporating contrast removal systems into clinical practice represents a major advancement in CI-AKI preventive approaches. These systems provide a proactive approach to managing exposure to contrast agents and the related adverse effects, potentially improving patient outcomes by mitigating the risk of renal injury associated with the administration of contrast media[3]. Staying updated on the latest research and incorporating innovative technologies such as contrast removal systems are crucial for optimizing renal protection and CI-AKI prevention[8,9], mitigating the nephrotoxic effects of contrast agents, and enhancing the safety of contrast-enhanced procedures in high-risk patient populations[1,6].

TAILORED PREVENTIVE APPROACHES

Tailored preventive approaches can facilitate the integration of novel approaches into clinical practice for CI-AKI prevention; such tailored approaches emphasize individualized care that is based on patient-specific risk factors and comorbidities[1]. Advanced preventive measures have substantial benefits for high-risk patients, including those with chronic kidney disease (CKD), diabetes mellitus, or heart failure[3,6]. Personalized approaches are tailored to each patient's unique medical profile and procedural risks, thus optimizing CI-AKI prevention[2,7]. For instance, intense preventive measures such as RenalGuard or contrast removal systems must be implemented in patients with underlying cardiovascular conditions or CKD for mitigating the nephrotoxic effects of contrast media[5,10]. Recent research has demonstrated the importance of incorporating emerging technologies and evidence-based practices into clinical workflows for improving outcomes in high-risk populations[11,12]. By staying updated on these advancements and by customizing preventive approaches according to each patient, health-care providers can effectively reduce the incidence of CI-AKI and enhance patient safety during contrast-enhanced procedures[8,9]. In summary, the implementation of tailored preventive approaches is pivotal for the management of CI-AKI; moreover, tailored preventive approaches can optimize patient outcomes through individualized risk assessment and intervention planning[3,6].

EVIDENCE-BASED PRACTICE

Evidence-based practice stipulates that the incorporation of emerging approaches into CI-AKI prevention protocols should be guided by the latest clinical evidence and guidelines[1]. Continual research and clinical trials are crucial for validating the efficacy of these approaches and for refining their application across diverse patient populations[2,3]. By staying updated on recent developments, health-care professionals can effectively incorporate novel preventive approaches such as RenalGuard and contrast removal systems into routine clinical practice[4,5]. These innovations are promising for high-risk individuals with preexisting renal or cardiovascular conditions; they can effectively mitigate the nephrotoxic effects of contrast media[6,10]. By staying updated on advancements in CI-AKI prevention, health-care providers can deliver optimal care through the implementation of treatment strategies that align with the latest scientific evidence[7,12]. In addition, by continually updating their knowledge base and adapting practices accordingly, clinicians can maximize the improvement of patient safety and outcomes during contrast-enhanced procedures[8,9]. In conclusion, the integration of evidence-based practice into CI-AKI prevention protocols represents a dynamic approach that considers recent research results and clinical insights. This dynamic approach fosters the incorporation of innovative strategies and ensures that preventive approaches are tailored to individual patient needs, thereby optimizing health-care delivery and patient outcomes[8,9].

INTERDISCIPLINARY COLLABORATION

CI-AKI prevention requires a collaborative approach involving radiologists, nephrologists, and other health-care professionals who are directly engaged in the care of patients undergoing contrast-enhanced procedures[1]. Effective interdisciplinary communication and coordination among these health-care professionals are fundamental to implementing comprehensive CI-AKI preventive approaches and achieving optimal patient outcomes[2,3]. Radiologists play pivotal roles in optimizing imaging protocols to minimize exposure to contrast agents without compromising diagnostic quality, thereby contributing to a reduced risk of CI-AKI[4,5]. Nephrologists also contribute to the reduction of CI-AKI risk by assessing patient risk factors and implementing personalized hydration protocols or pharmacological interventions

tailored to individual patient profiles[6,10]. Through the collaborative efforts of these specialists, appropriate CI-AKI preventive approaches can be selected, and any complications that develop can be promptly managed[7,12]. Moreover, continual interdisciplinary communication ensures that health-care providers stay updated on emerging research and innovative approaches, such as RenalGuard and contrast removal systems[8,9]. By staying updated on these advancements and by incorporating evidence-based practices into clinical workflows, interdisciplinary teams can enhance CI-AKI prevention and improve overall patient outcomes[8,9]. In conclusion, fostering collaboration among radiologists, nephrologists, and other health-care professionals is crucial for mitigating CI-AKI-associated risks. This collaborative approach not only optimizes patient safety during contrast-enhanced procedures but also supports the delivery of individualized care based on the latest scientific evidence and clinical guidelines[8,9].

CONCLUSION

In conclusion, this editorial verifies the pivotal insights from Theofilis and Kalaitzidis's comprehensive review of CI-AKI preventive approaches[1]. This review meticulously examines the current and emerging approaches for CI-AKI prevention, particularly highlighting innovative approaches such as RenalGuard and contrast removal systems[2,3]. CI-AKI remains a major challenge in clinical settings, especially among patients with underlying renal or cardiovascular conditions. Although traditional periprocedural hydration is fundamental, it has limited efficacy in high-risk individuals. The review verifies that new preventive measures must be adopted for providing enhanced renal protection and ensuring more favorable patient outcomes[1]. The RenalGuard system, which facilitates controlled diuresis, and contrast removal systems, which actively filter contrast agents from the circulation, represent notable advancements[4,5]. These innovations not only overcome the limitations of conventional methods but also align with personalized medicine principles by tailoring preventive approaches to individual patient profiles[7,12]. In the future, health-care providers must stay updated on these emerging techniques and must integrate them into clinical practice. Continual interdisciplinary collaboration and rigorous research are essential for validating these approaches across diverse patient populations[8,9]. By incorporating these advances into clinical practice, health-care providers can mitigate CI-AKI-associated risks, which can substantially improve patient outcomes.

FOOTNOTES

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Country of origin: Taiwan

ORCID number: Tzu-Hung Cheng 0000-0002-9155-4169.

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