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Management of renal emergencies in the new decade; innovations and the evolving role of the emergency physician

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Abstract

Emergency management of renal emergencies has seen remarkable evolution in recent years, with innovations enhancing outcomes and expanding the role of emergency physicians. In the new decade, these advances are shaped by cutting-edge clinical methodologies, integration of technology, and cross-disciplinary collaboration aimed at mitigating morbidity and mortality associated with acute and chronic renal crises. The emergency physician's role continues to evolve from initial stabilization and diagnosis towards spearheading early interventions, coordinating multidisciplinary care, and incorporating novel therapeutic options. Renal emergencies encompass acute kidney injury, severe electrolyte disturbances, fluid imbalances, complications from end-stage renal disease, and urgent needs in dialysis or transplant patients. Early and appropriate management is critical, as kidney conditions can lead rapidly to life-threatening systemic complications. Emergency physicians, positioned at the frontline, require specialized knowledge and protocols to identify underlying causes, assess complications affecting multisystem organ function, and promptly initiate treatment pathways that may include lifesaving renal replacement therapies. Innovations in this field include refined diagnostic tools such as point-of-care ultrasonography and biomarker assays that improve early detection and prognostication of kidney injury in unstable patients. Advanced laboratory markers distinguish intrinsic from prerenal or post-renal causes faster than conventional creatinine measurement alone, enabling targeted treatment. These advancements allow emergency physicians to differentiate reversible conditions requiring fluid resuscitation from those needing urgent renal replacement or surgical intervention.

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Introduction

Renal emergencies represent a critical subset of conditions encountered in the emergency department (ED), encompassing a spectrum of acute and life-threatening disorders that demand rapid recognition, timely intervention, and multidisciplinary coordination (1). As we progress through the new decade, marked by technological advancements, evolving healthcare delivery models, and an increasingly complex patient population, the role of the emergency physician in managing renal emergencies has expanded significantly (2). No longer confined to initial stabilization and disposition, the emergency physician now serves as a pivotal diagnostician, proceduralist, coordinator of care, and advocate for early nephrology engagement (3). This transformation is driven by innovations in point-of-care diagnostics, real-time monitoring, artificial intelligence, telemedicine, and a growing emphasis on precision medicine and systems-based practice (4). The landscape of renal emergencies, ranging from acute kidney injury (AKI), obstructive uropathy, and severe electrolyte disturbances to complications of chronic kidney disease (CKD) and end-stage renal disease (ESRD) is being reshaped by these developments, necessitating a reimagined approach to emergency renal care (5).

Search strategy

For this narrative review, we conducted a comprehensive literature search across multiple databases, including PubMed, Google Scholar, the Directory of Open Access Journals (DOAJ), Web of Science, EBSCO, Scopus, and Embase, using a variety of relevant keywords like emergency department, acute kidney injury, renal health, electrolyte disturbances, dialysis, chronic kidney disease, hyperkalemia, hyponatremia, end-stage renal disease and acid-base disturbances.

Key point

The emergency management of renal emergencies in the new decade is characterized by transformative innovations in diagnostics, therapies, and systems of care, alongside an expanded and more specialized role for the emergency physician. These advances collectively promise improved outcomes for patients facing life-threatening kidney complications, reinforcing the vital position of emergency medicine within the broader nephrology care continuum. This paradigm shift toward precision, rapid intervention and multidisciplinary coordination defines a new era in emergency renal care that aligns cutting-edge science with urgent clinical needs, finally saving lives and improving quality of care across diverse healthcare settings worldwide.

Management of AKI in the emergency department

Acute kidney injury remains one of the most common and consequential renal emergencies presenting to the ED (6). Defined by a rapid decline in kidney function over hours to days, AKI is associated with high morbidity, mortality, prolonged hospital stays, and increased healthcare costs (1). Historically, diagnosis relied on serum creatinine and urine output markers that are delayed, non-specific, and insensitive to early renal insult (7). However, the new decade has ushered in a paradigm shift toward earlier and more precise detection (7). Novel biomarkers such as neutrophil gelatinase-associated lipocalin, kidney injury molecule-1, and tissue inhibitor of metalloproteinase-2 combined with insulin-like growth factor-binding protein 7, commercially available as NephroCheck have demonstrated utility in predicting AKI before serum creatinine rises (8). While not yet universally adopted in routine ED practice, these biomarkers are increasingly integrated into risk-stratification protocols, particularly in high-risk populations such as those with sepsis, heart failure, or post-cardiac surgery (9). Emergency physicians are now positioned to leverage these tools not only for diagnosis but also for prognostication and early intervention, thereby altering the natural history of AKI (10). Moreover, the integration of electronic health records with clinical decision support systems has empowered emergency physicians to identify at-risk patients in real time (11). Algorithms embedded within electronic health records platforms can flag subtle changes in creatinine trends, fluid balance, or medication exposure that might otherwise go unnoticed during a busy shift (12). These systems can prompt clinicians to consider nephrotoxic agents, initiate fluid resuscitation protocols, or consult nephrology earlier than traditional practice would dictate (12). Such proactive management aligns with the broader movement toward predictive analytics in emergency medicine, where the goal is to prevent deterioration rather than merely respond to it (13). In this context, the emergency physician becomes a sentinel for renal health, using data-driven insights to avert full-blown renal crises (14). Meanwhile, obstructive uropathy, another critical renal emergency, often presents with flank pain, anuria, or signs of infection such as fever and sepsis (15). Timely decompression of the urinary tract is essential to preserve renal function and prevent systemic complications (16). Traditionally, management involved intravenous hydration, antibiotics for suspected infection, and urgent urologic consultation for procedures like nephrostomy or stent placement (15). However, the past decade has seen a remarkable expansion of procedural capabilities within the ED itself (17). Emergency physicians are increasingly trained in and performing bedside ultrasound-guided interventions, including percutaneous nephrostomy in select centers with appropriate protocols and oversight (18). While this remains a specialized skill, the trend reflects a broader shift toward procedural autonomy and rapid source control in the ED (1). Point-of-care ultrasound has become indispensable in the initial evaluation of suspected obstruction, allowing immediate visualization of hydronephrosis and guiding decisions about the urgency of intervention (19). This real-time imaging capability reduces reliance on delayed CT scans, minimizes radiation exposure, and accelerates time to definitive care (20). In parallel, innovations in imaging technology continue to refine diagnostic accuracy (21). Low-dose CT protocols and contrast-sparing techniques have mitigated concerns about contrast-induced nephropathy, particularly in patients with pre-existing CKD (22). Furthermore, the advent of artificial intelligence (AI)-assisted image interpretation promises to enhance diagnostic speed and reduce inter-observer variability (23). Meanwhile, AI algorithms can rapidly identify ureteral stones, assess degree of hydronephrosis, and even predict spontaneous passage likelihood information that directly informs disposition decisions (24). Emergency physicians, as the first interpreters of these studies, are uniquely positioned to integrate AI-generated insights with clinical judgment, ensuring that patients receive the right intervention at the right time (13).

Given that, electrolyte emergencies, particularly hyperkalemia, hyponatremia, and severe acid-base disturbances are frequent and potentially fatal presentations in the ED (25). Hyperkalemia, for instance, can cause lethal arrhythmias and requires immediate stabilization of the myocardium, followed by measures to shift potassium intracellularly and enhance its elimination (26). The new decade has introduced novel potassium-binding resins such as patiromer and sodium zirconium cyclosilicate, which offer more predictable and sustained potassium-lowering effects compared to older agents like sodium polystyrene sulfonate (27). While these medications are typically initiated in inpatient settings, their existence influences ED management by allowing for safer discharge of select patients with mild-to-moderate hyperkalemia under close follow-up, provided the underlying cause is addressed and arrhythmia risk is low (28). Emergency physicians must now navigate not only the acute stabilization but also the disposition implications of these newer therapies, balancing risk with resource utilization (29).

Similarly, the management of hyponatremia has evolved with a deeper understanding of its pathophysiology and the risks of overly rapid correction (30). The emergency physician must distinguish between acute and chronic hyponatremia, assess volume status, and tailor therapy accordingly (31). The availability of vaptans (vasopressin receptor antagonists), though limited by cost and side effect profiles, provides an additional tool in select cases of euvolemic or hypervolemic hyponatremia (32). More importantly, the emphasis has shifted toward cautious correction rates to avoid osmotic demyelination syndrome (33). This requires close monitoring and often admission, but in the ED, the emergency physician sets the tone for safe and evidence-based management from the outset (33). Real-time sodium monitoring via wearable or continuous blood gas analyzers, still largely experimental but under active development may soon allow for dynamic titration of therapy in the ED, further refining care (34).

Furthermore, the opioid epidemic and the rise of novel psychoactive substances have introduced new renal toxicities into the ED (35). Drug-induced AKI, rhabdomyolysis from prolonged immobilization or stimulant use (35), and crystal nephropathies from synthetic cannabinoids or adulterated substances are increasingly encountered (36). Emergency physicians must maintain a high index of suspicion and employ targeted diagnostic strategies, including urine toxicology, creatine kinase levels, and renal ultrasound (37). Innovations in toxicology screening, such as rapid mass spectrometry or point-of-care drug assays, may soon allow for faster identification of nephrotoxic agents, enabling tailored antidotal or supportive therapies (38). The emergency physician plays a crucial role in renal emergency management, particularly through harm reduction strategies. This involves a multi-faceted approach focused on patient well-being and long-term health. A key aspect of this role includes providing naloxone, a life-saving medication that can reverse opioid overdose (39). Simultaneously, physicians are responsible for connecting patients with essential addiction services, ensuring they receive comprehensive support beyond the ED. Furthermore, emergency physicians are vital in educating patients about renal risks, which empowers them to make informed decisions regarding their health. These combined efforts are now an integral component of effective renal emergency care (40-42). On the other hand, climate change and environmental factors also influence the epidemiology of renal emergencies (43). Heat-related illnesses, particularly exertional rhabdomyolysis and acute tubular necrosis from dehydration, are on the rise with increasing global temperatures (44). Emergency departments in affected regions must be prepared for seasonal surges in these conditions (45). Public health initiatives, early warning systems, and community education, often spearheaded or supported by emergency medicine professionals play a preventive role (46). In the ED, rapid cooling, aggressive fluid resuscitation, and monitoring for compartment syndrome or disseminated intravascular coagulation are critical (47). The emergency physician thus operates at the intersection of individual patient care and population health, responding to environmental determinants of renal disease (43).

The integration of genomics and personalized medicine, while still nascent in emergency settings, holds promise for the future of renal emergency care (48). Genetic variants influencing drug metabolism (e.g., angiotensin-converting enzyme inhibitors or non-steroidal anti-inflammatory drugs) or predisposition to certain forms of glomerulonephritis may one day inform real-time treatment decisions (49). Pharmacogenomic data embedded in electronic health records could alert emergency physicians to high-risk medication choices, preventing iatrogenic renal injury (12). Though such applications are not yet routine, the trajectory points toward a more individualized approach, where the emergency physician tailors interventions based on a patient's unique biological profile (12).

Management of CKD in the emergency department

Patients with CKD and ESRD present unique challenges in the emergency setting (50). They are at heightened risk for cardiovascular events, infections, and metabolic derangements due to their underlying renal dysfunction and comorbidities (51). Missed or shortened dialysis sessions, vascular access complications (e.g., thrombosed fistulas, infected catheters), and dialysis disequilibrium syndrome are common reasons for ED visits (52). The emergency physician must rapidly assess whether the presentation is dialysis-related or due to an independent acute process (53). Innovations in remote patient monitoring are beginning to transform this landscape (54). Wearable devices that track fluid status, blood pressure, and even electrolyte trends can alert both patients and providers to impending complications before they become emergencies (55). In the ED, access to this longitudinal data, which integrated into the electronic health records can provide invaluable context, distinguishing chronic baseline abnormalities from acute changes (56). This data-rich environment enables more precise decision-making and reduces unnecessary admissions (57).

Recently, tele-nephrology has emerged as a powerful adjunct to emergency care, particularly in resource-limited settings (58). Through secure video platforms, emergency physicians can consult nephrologists in real time, sharing point-of-care ultrasound images, lab results, and clinical assessments to co-manage complex cases (59). This not only expedites specialty input but also educates the emergency team, fostering a collaborative model of care (59). In rural or underserved areas where nephrology coverage is sparse, tele-nephrology can be lifesaving, ensuring that patients with renal emergencies receive expert guidance without delay (60). The emergency physician thus acts as the on-the-ground coordinator, leveraging virtual expertise to optimize outcomes (60).

The role of the emergency physician has also expanded into the realm of palliative care for patients with advanced CKD or ESRD (61). Many of these cases face recurrent hospitalizations, declining quality of life, and uncertain prognoses (62). Emergency departments are often the entry point for discussions about goals of care, particularly during acute decompensations (50). The new decade emphasizes early integration of palliative principles, and emergency physicians are increasingly trained to initiate these sensitive conversations (63). Recognizing when aggressive medical interventions may be futile or misaligned with a patient's values is a crucial skill for healthcare professionals. This understanding is foundational to providing patient-centered care and ensuring that medical treatments genuinely serve the individual's best interests. It requires a delicate balance of medical knowledge and empathetic communication (64). Accordingly, shared decision-making tools, enhanced by decision aids and electronic health record prompts, can significantly facilitate these sensitive discussions. These tools provide structured frameworks and readily accessible information, empowering both patients and clinicians to explore treatment options, potential outcomes, and personal preferences in a comprehensive manner. By integrating these resources, healthcare teams can foster a more collaborative and informed decision-making process. Finally, integrating these resources helps ensure that medical decisions are not solely based on clinical indications but also deeply respect the patient's autonomy and quality of life goals. This approach enhances trust between patients and providers, leading to more meaningful and ethically sound healthcare outcomes (65-67). In this capacity, the emergency physician serves not only as a resuscitator but also as a compassionate guide, helping patients navigate the complexities of ESRD (53). Likewise, the evolving pharmacological landscape, including the expanded administration of sodium-glucose co-transporter 2 inhibitors and other renoprotective agents, affects emergency management strategies (68). Recognizing their impact on hemodynamics and electrolyte balance helps emergency physicians optimize treatment in acute settings, including infections or cardiovascular events (1).

A short look at kidney replacement therapies

The expanding availability of kidney replacement therapies in emergency settings represents a major step forward (69). High-efficiency, portable dialysis machines and peritoneal dialysis options tailored for emergencies have transformed care, enabling timely intervention even in resource-limited or disaster-affected environments (70). These innovations are crucial for rapid correction of electrolyte imbalances and volume overload, especially when conventional inpatient dialysis units are overwhelmed or inaccessible (71). Emergency physicians increasingly participate in initiating and managing these therapies in collaboration with nephrology and critical care teams, necessitating cross-training and competency development (72). Advances in immunological understanding and transplantation medicine also influence emergency management (72). Novel protocols such as the dual immune/solid organ transplant procedure enable some patients previously considered unmanageable in emergency settings to achieve curative outcomes with reduced immunosuppressive burden (73). Awareness and readiness to engage with evolving transplantation paradigms are increasingly vital components of emergency nephrology care pathways. These advancements are significantly broadening the scope of available therapeutic options for patients. This proactive approach ensures that nephrology professionals are well-prepared to integrate novel transplantation strategies into their clinical practice. Ultimately, this leads to improved patient outcomes and more comprehensive care within the field. By embracing these new paradigms, emergency nephrology can continue to innovate and provide cutting-edge treatments. This condition allows for a more dynamic and effective response to complex renal conditions, pushing the boundaries of what is therapeutically possible (74,75).

Focus on quality improvement

Quality improvement initiatives further underscore the emergency physician's leadership role (76). By analyzing ED data on renal emergency outcomes—such as time to nephrology consultation, rates of contrast-induced AKI, or readmission after hyperkalemia—EDs can implement targeted interventions (77). Previous authors demonstrated that, a standardized order sets for AKI workup, automatic alerts for high-risk medications in CKD patients, or pathways for expedited outpatient follow-up after mild electrolyte disturbances can reduce errors and improve continuity (10). Emergency physicians often lead these initiatives, using their frontline perspective to drive system-level change (78).

Impact of education and training

Education and training have also evolved to meet these expanding demands (79). Emergency medicine residencies now incorporate dedicated nephrology rotations, simulation-based training for renal emergencies, and competency assessments in point-of-care ultrasound and procedural skills (80). Continuing medical education emphasizes interdisciplinary collaboration, ethical decision-making in ESRD, and the use of emerging technologies (81). The modern emergency physician is expected to possess not only broad clinical acumen but also systems-thinking skills to navigate complex care pathways and advocate for patients within fragmented healthcare systems (82).

Conclusion

In the new decade, emergency management of renal emergencies has evolved dramatically, expanding the emergency physician's role from initial stabilization to active leadership in comprehensive care. Advances in medical technology and deeper insights into renal pathophysiology now enable earlier and more precise interventions. Novel biomarkers supplement traditional labs, allowing rapid detection of AKI, glomerular diseases, and electrolyte imbalances, often before severe complications arise, thereby improving outcomes and reducing progression to CKD or dialysis dependence. Artificial intelligence and machine learning further enhance care through predictive analytics and decision support. Meanwhile, AI systems analyze electronic health records and imaging to stratify risk, flag high-risk patients and prioritize critical cases boosting both efficiency and accuracy in busy EDs. Emergency physicians are also performing advanced bedside procedures, such as ultrasound-guided urinary catheterization for obstruction, urgent vascular access for dialysis, and initiation of continuous renal replacement therapy in critically ill patients. These skills shorten time to definitive treatment, minimizing irreversible kidney damage. Importantly, care has become more patient-centered. Emergency providers now engage in goals-of-care discussions and palliative planning for ESRD patients, aligning interventions with patient values. This shift demands continuous learning and strong interdisciplinary collaboration with nephrology, critical care, cardiology, and infectious disease specialists. As patient complexity grows, the emergency physician's role in renal emergencies will continue to expand, requiring precision diagnostics, individualized treatment, and compassionate, holistic care.

Authors' contribution

Conceptualization: Mohammad Reza Moonesan.
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Writing–review and editing: Mohammad Reza Moonesan, Majid Foroutan.

Conflicts of interest

The authors declare that they have no competing interests.

Ethical issues

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors utilized Perplexity to refine grammar points and language style in writing. Subsequently, the authors thoroughly reviewed and edited the content as necessary, assuming full responsibility for the publication's content.

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