

IV Contrast for MRI and CT in Patients with Kidney Disease Care Process Model Synopsis

IV Contrast for MRI in Patients with Kidney Disease CPM  Evidence Based Practice

Inclusion Criteria

- Age 1 year to 25 years
- Inpatient, outpatient, observation

Exclusion Criteria

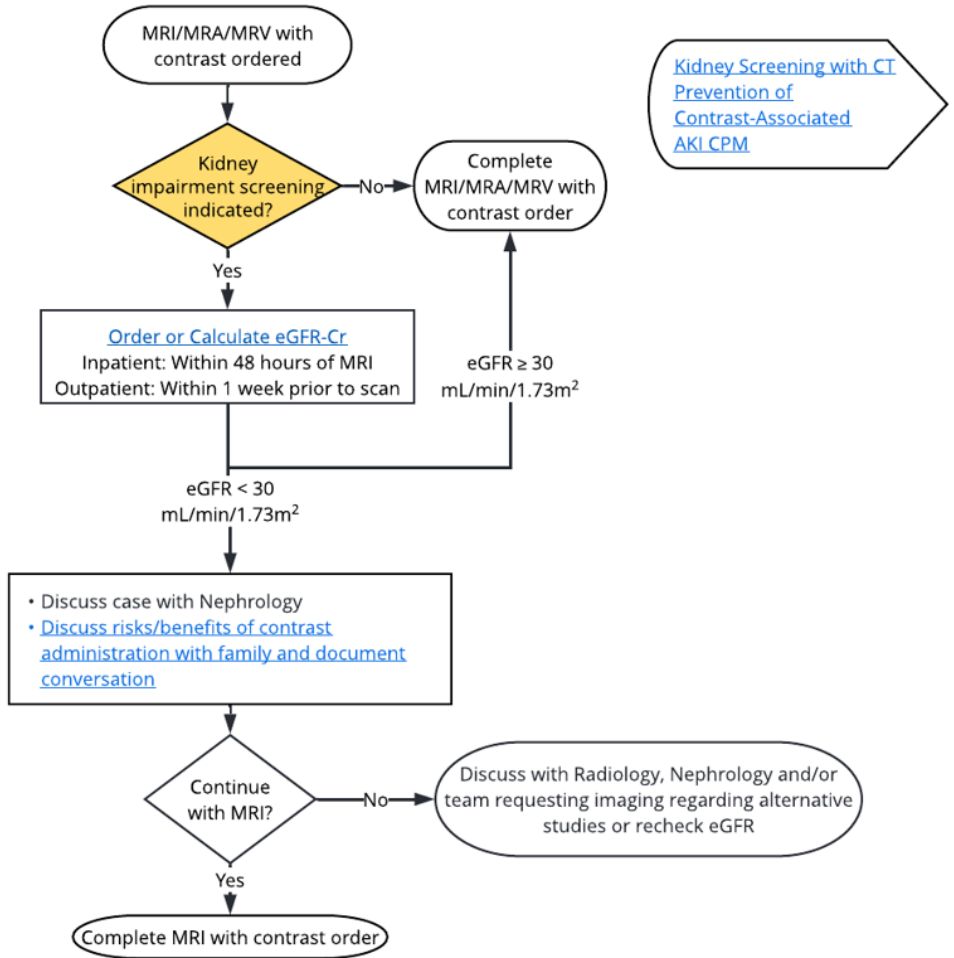
- Emergent or Critical: **MRI should not be delayed in critical situations**
- < 1 year of age
- Hospice care

Screening indicated if:

- History of AKI or CKD
- History of kidney surgery or ablation
- [Patient at risk for acute kidney injury](#)

Abbreviations (lab & radiology excluded):

- **AKI** = Acute kidney injury
- **CA-AKI** = [Contrast-associated acute kidney injury](#)
- **PC-AKI** = Post-contrast acute kidney injury
- **eGFR** = Estimated Glomerular Filtration Rate
- **CKD** = Chronic Kidney Disease



Contact: EvidenceBasedPractice@cmh.edu For additional information, [link to synopsis](#) Last Updated: 12.2022

This care process model/clinical practice guideline is meant as a guide for the healthcare provider, does not establish a standard of care, and is not a substitute for medical judgment which should be applied based upon the individual circumstances and clinical condition of the patient.

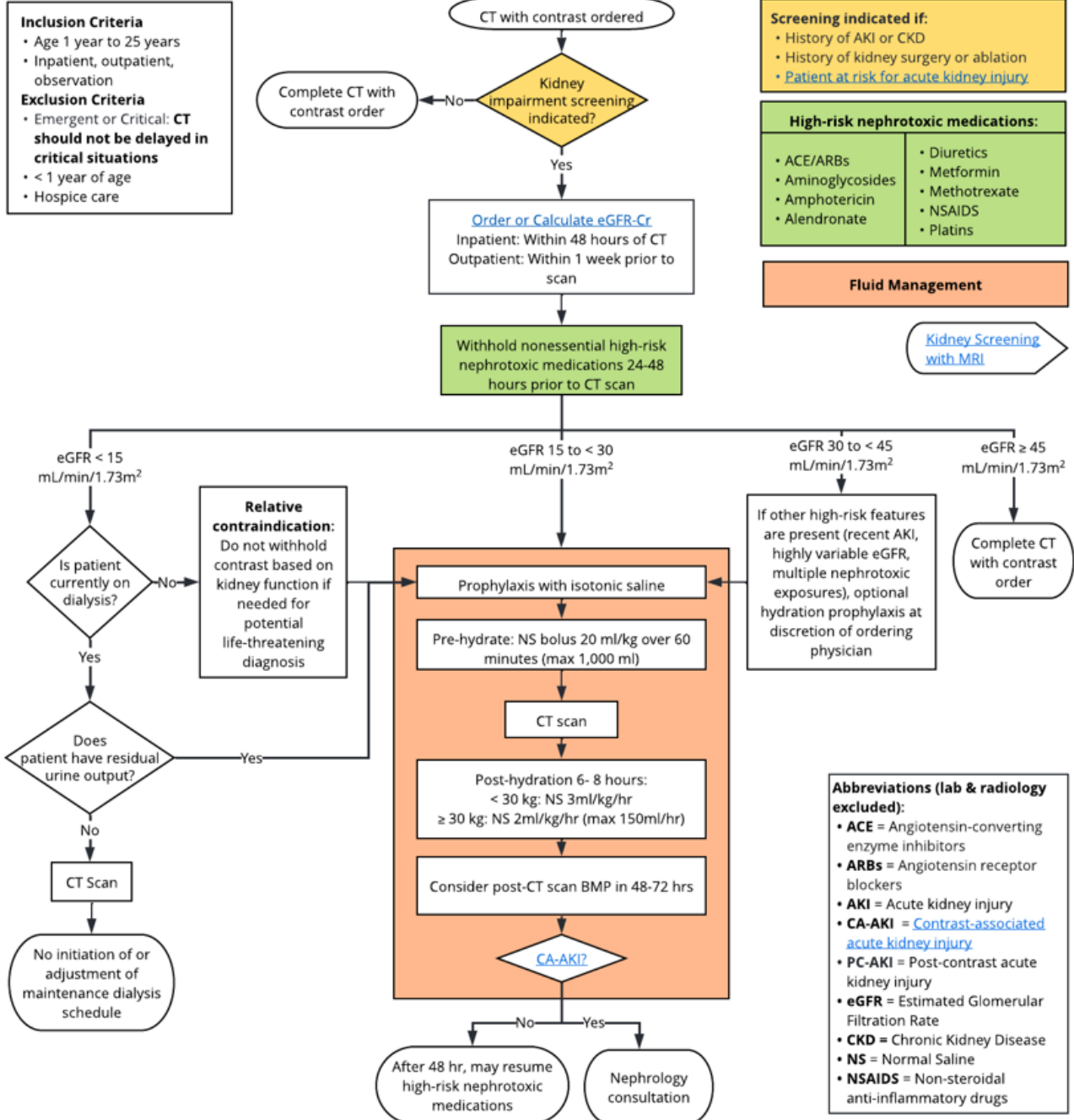
**This care process model does not establish a standard of care to be followed in every case. It is recognized that each case is different, and those individuals involved in providing health care are expected to use their judgment in determining what is in the best interests of the patient based on the circumstances existing at the time. It is impossible to anticipate all possible situations that may exist and to prepare care process models for each. Accordingly, this care process model should guide care with the understanding that departures from them may be required at times.*

IV Contrast for CT in Patient with Kidney Disease and Prevention of Contrast-Associated AKI CPM



Children's Mercy KANSAS CITY

Evidence Based Practice



Contact: EvidenceBasedPractice@cmh.edu

Last Updated: 12.2022

For additional information, [link to synopsis](#)

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Objective of Care Process Model

To provide care standards for the patient who is at risk for or diagnosed with kidney impairment and the use of intravenous (IV) contrast for a magnetic resonance imaging (MRI) scan, magnetic resonance angiography (MRA), magnetic resonance venography (MRV) or a computed tomography (CT) scan. The Contrast MRI and CT in Kidney Disease Care Process Model is intended to align CMH provider practices with new consensus recommendations from the American College of Radiology and the National Kidney Foundation regarding the pretreatment and treatment of patients with kidney impairment who have indication(s) to receive IV contrast with diagnostic imaging techniques.

Background

Contrast media, such as intravenous iodine and gadolinium-based contrast agents, plays an important role in diagnostic imaging techniques to evaluate a disease process and inform a provider or providers of a patient's response to treatment (Davenport et al., 2020; Weinreb et al., 2021). Historically, perceived risk of contrast-associated acute kidney injury (CA-AKI), nephrogenic systemic fibrosis (NSF), or nephrotoxicity in response to the use of or repeated exposure to contrast media resulted in the delay or denial of diagnostic imaging techniques for patients with reduced kidney function (Davenport et al., 2015; Davenport et al., 2020; Weinreb et al., 2021). Additionally, varying levels of uncertainty amongst providers surrounding the use of contrast media with diagnostic imaging for patients with reduced kidney function led to inconsistent clinical practices (Weinreb, et al. 2021).

Realizing the potential for inconsistent clinical practices, data was pooled for the number of CT scans and MRI scans ordered at CMH in 2021 (Mitchell et al., 2022). Data suggests a total of $N = 8,236$ CT ($n = 3,295$) and MRI ($n = 4,941$) scans with contrast were ordered. The data was further analyzed to determine the number of CT or MRI scans with contrast ordered for children with kidney disease. For children with kidney disease, a total of $N = 511$ CT ($n=312$) and MRI ($n = 199$) scans with contrast were ordered (Mitchell et al., 2022). While the differences between the number of CT and MRI scans with contrast ordered for children with kidney disease in 2021 is unknown, the American College of Radiology and the National Kidney Foundation (Davenport et al., 2020; Weinreb et al., 2021) have released consensus recommendations regarding the use of contrast media for MRI and CT scans, including for individuals with kidney disease. The consensus recommendations are a shift from an historical perspective and designed to provide evidence-based strategies and decision support, specifically pertaining to the use of IV contrast during diagnostic imaging techniques, for providers caring for patients with a diagnosis of kidney disease.

Target Users

- Physicians and providers treating patients with or at risk for kidney impairment

Target Population

CPM Inclusion Criteria

- Patient between the ages of 1-25 years
- Patient who is considered inpatient, outpatient, or observation

CPM Exclusion Criteria

- Patient who is considered emergent or critical (**imaging should not be delayed in critical situations**)
- Patient less than one year of age
- Patient under hospice care

AGREE II

The American College of Radiology (ACR) and National Kidney Foundation (NKF) consensus statements provided guidance to the Contrast MRI and CT in Kidney Disease Committee (Davenport et al., 2020; Weinreb et al., 2021). See Table 1 and 2 for AGREE II.

Table 1

AGREE II^a Summary for the ACR and NKF Use of IV Iodinated Contrast Media Consensus Statements (Davenport et al., 2020)

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Domain	Percent Agreement	Percent Justification [^]
Scope and purpose	90%	The aim of the consensus statements, the clinical questions posed, and target populations were identified.
Stakeholder involvement	69%	The consensus statements were developed by the appropriate stakeholders. The consensus statements did not include the viewpoints of the intended user.
Rigor of development	49%	The developers of the consensus statements did not provide how the evidence was gathered and synthesized, how the recommendations were formulated nor how the statements will be updated.
Clarity and presentation	88%	The recommendations of the consensus statements are clear, unambiguous, and easily identified; in addition, different management options are presented.
Applicability	54%	The consensus statements did not fully address implementation barriers and facilitators, utilization strategies, nor resource costs associated with implementation.
Editorial independence	98%	The recommendations were not biased with competing interests.

Note: Four EBP Scholars completed the AGREE II on this guideline.

[^]Percentage justification is an interpretation based on the Children's Mercy EBP Department standards.

Table 2

AGREE II^a Summary for the ACR and NKF Use of IV Gadolinium-Based Contrast Media Consensus Statements (Weinreb et al., 2021)

Domain	Percent Agreement	Percent Justification [^]
Scope and purpose	97%	The aim of the consensus statements, the clinical questions posed, and target populations were identified.
Stakeholder involvement	75%	The consensus statements were developed by the appropriate stakeholders. The consensus statements did not include the viewpoints of the intended user.
Rigor of development	50%	The developers of the consensus statements did describe the methods for formulating the recommendations, though did not provide how the evidence was gathered and synthesized, nor how the consensus statements would be updated.
Clarity and presentation	83%	The consensus statement recommendations are clear, unambiguous, and easily identified; however, different management options were not presented.
Applicability	46%	Barriers and facilitators to implementation and strategies to improve utilization were addressed in the consensus statement. The consensus statement did not address resource costs associated with implementation.
Editorial independence	100%	The recommendations were not biased with competing interests.

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Care Management Recommendations Based on Standards of Care and Expert Opinions

Kidney Screening for MRI

- When an MRI, MRA, or MRV with contrast is ordered, kidney impairment screening is indicated in the following conditions:
 - The patient has a history of acute or chronic kidney disease
 - The patient has a history of kidney surgery or ablation
 - The patient is considered high risk for acute kidney injury
- If kidney impairment screening is not indicated, complete the MRI, MRA, or MRV with contrast order
- If kidney impairment screening is indicated, order an estimated glomerular filtration rate-creatinine (eGFR-Cr)
 - If the patient is inpatient, the eGFR-Cr must be within 48 hours of the scan
 - If the patient is outpatient, the eGFR-Cr must be within one week prior to the scan
 - When ordering an eGFR-Cr, a current height is needed
- If the eGFR ≥ 30 mL/min/1.73m², complete the MRI, MRA, MRV with contrast order
- If the eGFR < 30 mL/min/1.73m²,
 - Discuss the case with Nephrology
 - Discuss risks/benefits of contrast administration with family and document the conversation in the medical record.
- If the decision is not to continue with the MRI, MRA, or MRV following the case discussion with Nephrology and/or discussion of risks and benefits with the family, discuss alternative imaging options with Radiology and/or Nephrology or recheck eGFR
- If the decision is to continue with MRI, MRA, or MRV, complete the MRI, MRA, or MRV with contrast order

Kidney Screening for CT and Prevention of CA-AKI

- When a CT with contrast is ordered, kidney impairment screening is indicated in the following conditions:
 - The patient has a personal history of acute or chronic kidney disease
 - The patient has a history of kidney surgery or ablation
 - The patient is considered high risk for acute kidney injury
- If kidney impairment screening is not indicated, complete the CT scan with contrast order
- If kidney impairment screening is indicated, order an eGFR-Cr,
 - If the patient is inpatient, the eGFR-Cr must be completed within 48 hours of the CT scan
 - If the patient is outpatient, the eGFR-Cr must be completed within one week prior to the CT scan
 - When ordering an eGFR-Cr, a current height is needed
- Once proceeding with the CT scan, withhold nonessential high-risk nephrotoxic medications 24-48 hours prior to the scan. Nephrotoxic medications include, non-steroidal anti-inflammatory drugs (NSAID), diuretics, aminoglycosides, amphotericin, platins, zoledronate, methotrexate, angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARB), metformin
- If the eGFR > 45 mL/min/1.73m², order the CT scan with contrast
- If eGFR is 30 – 45 mL/min/1.73m² and the patient presents with other high-risk features such as, a recent acute kidney injury, a highly variable eGFR, or multiple nephrotoxic exposures, the patient may receive an optional hydration prophylaxis at the discretion of the ordering physician
- If the optional hydration prophylaxis (intravenous isotonic saline) is recommended, proceed as follows:
 - Pre-hydrate with a normal saline (NS) bolus at 20 ml/kg over 60 minutes for a maximum of 1,000 ml
 - Complete the CT scan
 - Following the CT scan, post-hydrate for 6–8 hours
 - If the patient weighs < 30 kg, hydrate at 3 mL/kg/hr
 - If the patient weighs ≥ 30 kg, hydrate at 2 mL/kg/hr for a maximum of 150 ml
 - Consider ordering a post-basic metabolic panel (BMP) between 48-72 hours following the CT scan
 - If the patient is showing signs of CA-AKI, consult Nephrology
 - If the patient is not showing signs of CA-AKI, high-risk nephrotoxic medications may be resumed after 48 hours

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- If eGFR is 15 – 30 mL/min/1.73m², proceed with hydration prophylaxis (intravenous isotonic saline) as follows:
 - Pre-hydrate with NS bolus at 20 mL/kg over 60 minutes for a maximum of 1,000 mL
 - Complete the CT scan
 - Following the CT scan, continue hydration for an additional 6-8 hours
 - If the patient weighs < 30 kg, hydrate at 3 mL/kg/hr
 - If the patient weighs ≥ 30 kg, hydrate at 2 mL/kg/hr for a maximum of 150 mL
 - Consider ordering a post-BMP between 48-72 hours following the CT scan
 - If the patient is showing signs of CA-AKI, consult Nephrology
 - If the patient is not showing signs of CA-AKI, high-risk nephrotoxic medications may be resumed after 48 hours
- If eGFR < 15 mL/min/1.73m², the patient is not receiving dialysis, and the provider recognizes the relative contraindication that use of contrast based on kidney function should not be withheld if needed for a potential life-threatening diagnosis, proceed with hydration prophylaxis (intravenous isotonic saline) as follows:
 - Pre-hydrate with NS bolus at 20 mL/kg over 60 minutes for a maximum of 1,000 mL
 - Complete the CT scan
 - Following the CT scan, continue hydration for for an additional 6-8 hours
 - If the patient weighs < 30 kg, hydrate at 3 mL/kg/hr
 - If the patient weighs ≥ 30 kg, hydrate at 2 mL/kg/hr for a maximum of 150 mL
 - Consider ordering a post-BMP between 48-72 hours following the CT scan
 - If the patient is showing signs of CA-AKI, consult Nephrology
 - If the patient is not showing signs of CA-AKI, high-risk nephrotoxic medications may be resumed after 48 hours
- If eGFR < 15 mL/min/1.73m², the patient is receiving dialysis, and the patient has clinically significant residual kidney function, proceed with hydration prophylaxis (intravenous isotonic saline) as follows:
 - Pre-hydrate with NS bolus at 20 ml/kg over 60 minutes for a maximum of 1,000 ml
 - Complete the CT scan
 - Following the CT scan, continue hydration for an additional 6-8 hours
 - If the patient weighs < 30 kg, hydrate at 3 mL/kg/hr
 - If the patient weighs > 30 kg, hydrate at 2 mL/kg/hr for a maximum of 150 mL
 - Consider ordering a post-BMP between 48-72 hours following the CT scan
 - If the patient is showing signs of CA-AKI, consult Nephrology
 - If the patient is not showing signs of CA-AKI, high-risk nephrotoxic medications may be resumed after 48 hours
- If eGFR < 15 mL/min/1.73m², the patient is receiving dialysis, and the patient does not have clinically significant residual kidney function, proceed with the CT scan with contrast.
- Dialysis should not be initiated or result in a schedule adjustment based purely on the use of contrast media.

Additional Questions Posed by the CPM Committee

No clinical questions were posed for this review.

Children's Mercy Practice Recommendations and Reasoning

Children's Mercy adopted most of the practice recommendations made by the American College of Radiology and the National Kidney Foundation consensus statements (Davenport et al., 2020; Weinreb et al., 2021).

Variations/Additions include:

Contrast MRI

- A kidney impairment screening be conducted for all patients with history of acute or chronic kidney disease regardless of gadolinium-containing contrast media (GBCM) group classification, whereas the ACR and NKF consensus statements suggest that kidney screening is optional when using group II GBCM, though necessary when using group III GBCM in patients with kidney disease (Weinreb et al., 2021)
- All cases for patients with an eGFR < 30 mL/min/1.73m² should be discussed with a Nephrologist prior to proceeding with an MRI with contrast, whereas the ACR and NKF consensus statements suggest that communication occur between the radiologist and ordering physician only when group III GBCM

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administration is considered in patients with an eGFR < 30 mL/min/1.73m² or an acute kidney injury (Weinreb et al., 2021)

Contrast CT

- Patients considered at risk include those with a history of acute or chronic kidney disease, history of kidney surgery or ablation, complex congenital heart disease, those with an eGFR < 30 mL/min/1.73m², and those with an eGFR < 45 mL/min/1.73m² demonstrating other high risk features (recent acute kidney injury, highly variable eGFR, or multiple nephrotoxic exposures), whereas the ACR and NKF consensus statements suggest patients at risk include those with recent acute kidney injury, those with an eGFR < 30 mL/min/1.73m², including nonanuric patients undergoing maintenance dialysis (Davenport et al, 2020)
- A kidney impairment screening be conducted for all patients with history of acute or chronic kidney disease, history of kidney surgery or ablation, and complex congenital heart disease, whereas the ACR and NKF consensus statements suggest a kidney impairment screen be completed for patients with a personal history of chronic kidney disease, remote acute kidney injury, kidney surgery or ablation (Davenport et al., 2020)
- Prophylaxis with normal saline is recommended for patients with an eGFR < 15 mL/min/1.73m² with clinically significant kidney function, all patients with an eGFR < 30 mL/min/1.73m², and considered for patients with an eGFR < 45 mL/min/1.73m² when accompanied by other high risk features (recent acute kidney injury, highly variable eGFR, multiple nephrotoxic exposures), whereas the ACR and NKF consensus statements suggest prophylaxis with normal saline for patients not undergoing dialysis who have an eGFR < 30 mL/min/1.73m² or acute kidney injury and considered for patients with an eGFR 30-44 mL/min/1.73m² when accompanied by high risk features (Davenport et al., 2020)

Measures

- MRI/MRA/MRV Kidney Screen
- CT Kidney Screen

Potential Cost Implications

The following potential improvements may reduce costs and resource utilization for healthcare facilities and reduce healthcare costs and non-monetary costs (e.g., missed school/work, loss of wages, stress) for patients and families.

- Decreased unwarranted variation in care
- Decreased potential delay in diagnosis or treatment
- Decreased risk of overdiagnosis
- Decreased risk of overtreatment
- Decreased frequency of admission
- Decreased inpatient length of stay

Potential Organizational Barriers and Facilitators**Potential Barriers**

- Variability of acceptable level of risk among providers
- Challenges with follow-up faced by some families

Potential Facilitators

- Collaborative engagement across care continuum settings during CPM development
- High rate of use of CPM
- Standardized order set for Urgent Care Clinic, Emergency Department, Hospital Medicine, and Pediatric Intensive Care

Power Plans

- Under development

Associated Policies

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- IV Contrast Administration (2021)
- Standing Order for Contrast Administration (2021)

Care Process Preparation

This care process was prepared by the Evidence Based Practice Department (EBP) in collaboration with content experts at Children's Mercy Kansas City. Development of this care process supports the Division of Quality Excellence and Safety's initiative to promote care standardization that is evidenced by measured outcomes. If a conflict of interest is identified the conflict will be disclosed next to the committee member's name.

Implementation & Follow-Up

Once approved, the CPM was presented to appropriate care teams and implemented. Care measurements will be assessed and shared with appropriate care teams to determine if changes need to occur. This CPM is scheduled for revision October 2024.

Contrast MRI and CT in Kidney Disease CPM Committee Members

- Darcy Weidemann, MD, MHS | Nephrology | Committee Co-Chair
- Grace Mitchell, MD, MBA | Radiology | Committee Co-Chair
- Joel Thompson, MD | Hematology/Oncology/BMT | Committee Member
- Shobhit Jain, MD | Emergency Medicine | Committee Member
- Adrienne DePorre, MD | Hospital Medicine | Committee Member
- Joel Koenig, MD | Urology | Committee Member

EBP Committee Members

- Todd Glenski, MD, MSHA, FASA | Anesthesiology, Evidence Based Practice
- Jarrod Dusin, MS, RD, LD, CPHQ | Evidence Based Practice
- Kelli Ott, OTD, OTR/L | Evidence Based Practice

Additional Review & Feedback

- The CPM was presented to each division or department represented on the CPM committee as well as other appropriate stakeholders. Feedback was incorporated into the final product.

Care Process Model Development Funding

The development of this guideline was underwritten by the EBP, Nephrology, Radiology, Hematology/Oncology/BMT, Emergency Medicine, Hospital Medicine, and Urology Departments.

Conflict of Interest

The contributors to the Contrast MRI and CT in Kidney Disease Care Process Model have no conflicts of interest to disclose related to the subject matter or materials discussed in this care process.

Approval Obtained

Department/Unit	Date Approved
Nephrology	October, 2022
Radiology	October, 2022
Emergency Medicine	October, 2022
Hospital Medicine	October, 2022
Hematology/Oncology/BMT	October, 2022

Version History

Date	Comments
December 2022	Version one

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Disclaimer

When evidence is lacking or inconclusive, options in care are provided in the guideline and the power plans that accompany the guideline.

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References

- Davenport, M.S., Cohan, R.H., & Ellis, J.H. (2015). Contrast media controversies in 2015: Imaging patient with renal impairment or risk of contrast reaction. *American Journal of Radiology*, 204(6), 1174-1181. <https://doi:10.2214/AJR.14.14259>
- Davenport, M.S., Perazella, M.A., Yee, J., Dillman, J.R., Fine, D., McDonald, R.J., Rodby, R.A., Wang, C.L., & Weinreb, J.C. (2020). Use of intravenous iodinated contrast media in patients with kidney disease: Consensus statements from the American College of Radiology and the National Kidney Foundation. *Radiology*, 294(3), 660-668. <https://doi.org/10.1148/radiol.2019192094>
- IV Contrast Administration (December, 2021), *CMH Patient Care Services Medication Manual*. Children's Mercy Hospital, Kansas City, Missouri.
- Mitchell, G.S., & Weidemann, D. (2022, May 19). *IV contrast with MRI & CT: Updates and recommendations in impaired kidney function* [Grand Rounds session]. Children's Mercy Kansas City Grand Rounds, Kansas City, MO, United States. <https://scope.cmh.edu/news/2022/05/18/grand-rounds-thursday-iv-contrast-with-mri-and-ct--updates-and-recommendations-in-renal-failure/>
- Selewski DT, Askenazi DJ, Kashani K, Basu RK, Gist KM, Harer MW, Jetton JG, Sutherland SM, Zappitelli M, Ronco C, Goldstein SL, Mottes TA. Quality improvement goals for pediatric acute kidney injury: pediatric applications of the 22nd Acute Disease Quality Initiative (ADQI) conference. *Pediatr Nephrol*. 2021 Apr;36(4):733-746. doi: 10.1007/s00467-020-04828-5. Epub 2021 Jan 12. PMID: 33433708.
- Standing Order for Contrast Administration (December, 2021), *CMH Patient Care Services Standing Orders Manual*. Children's Mercy Hospital, Kansas City, Missouri.
- Weinreb, J.C., Rodby, R.A., Yee, J., Wang, C.L., Fine, D., McDonald, R.J., Perazella, M.A., Dillman, J.R., & Davenport, M.S. (2021). Use of intravenous gadolinium-based contrast media in patients with kidney disease: Consensus statement from the American College of Radiology and the National Kidney Foundation. *Radiology*, 298(1), 28-35. <https://doi.org/10.1148/radiol.2020202903>

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