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Clinical Pearl: Artificial Intelligence, Machine Learning Models in Neonatology: Neonatal Acute Kidney Injury

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AI is a "branch of computer science that develops systems capable of human-like intellectual processes to solve problems. ML, a subset of AI, uses large data sets and some human input (adding or changing parameters) to teach itself patterns and to make predictions (6)".

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Neonatal acute kidney injury (AKI) is a common clinical problem in neonates, especially in both premature infants and term infants who have undergone cardiac or abdominal surgery (2-4), and it holds great promise for the use of AI and ML clinically. The most recent gold standard definition of neonatal AKI is the neonatal-modified Kidney Disease: Improving Global Outcomes (KDIGO) definition, which is summarized in the table from a review by Coleman et al. (3) as well as by Starr and colleagues and involves AKI staging (0,1,2,3) based on serum criteria and hourly urine output (2,4).

It is also vital to understand embryology and that nephrogenesis begins at five weeks gestation and continues until 34 to 36 weeks gestation (2). The nephron number is highly variable, particularly in premature infants (2). Renal blood flow and perfusion pressure also increase over the first few weeks of post-natal life, as does the proportion of cardiac output to the kidney (2). Several factors affect renal blood flow and perfusion pressure, including hypotension, hemorrhage, hypoxic-ischemic encephalopathy, nephrotoxic medications, sepsis, and congenital heart disease, for example (2).

"There have been a couple of projects using AI and ML models to predict neonatal AKI, as well as to reduce the incidence of AKI in neonates by making clinicians more aware of these factors that contribute to the development of neonatal AKI: 'STARZ risk stratification AI model which was incorporated in the electronic medical record (EMR) and showed a predictive ability of AKI within seven days of NICU admission of the area under the curve (AUC) of 0.93 and AUC of 0.96 in the validation and derivation cohorts, respectively (3)'."

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TABLE 1 | Neonatal acute kidney injury diagnostic criteria.

AKI stage	Serum creatinine (SCr) criteria	Urine output criteria (hourly rate)
0	No change in SCr *or* SCr rise < 0.3 mg/dL	≥0.5 ml/kg/h
1	SCr rise ≥ 0.3 mg/dL rise within 48 h *or* SCr rise ≥ 1.5–1.9 × baseline SCr[a]	<0.5 ml/kg/h × 6–12 h
2	SCr rise ≥ 2.0–2.9 × baseline SCr[a]	<0.5 ml/kg/h for >12 h
3	SCr rise ≥ 3 × baseline SCr[a] *or* SCr ≥ 2.5 mg/dL[b] *or* Kidney support therapy utilization	<0.3 ml/kg/h for ≥24 h *or* Anuria for ≥12 h

Modified, neonatal Kidney Disease: Improving Global Outcomes (KDIGO) criteria. [a]Baseline SCr defined as lowest previous SCr value. [b]SCr value of 2.5 mg/dL represents glomerular filtration rate of <10 mL/min/1.73 m^2. SCr, serum creatinine; mg/dL, milligrams per deciliter; h, hours. Adapted from Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Workgroup. KDIGO clinical practice guideline for acute kidney injury. Kidney Int Suppl 2012;2:1–138.

Table reprinted with permission: Coleman C, Tambay Perez A, Selewski DT, Steflik HJ. Neonatal Acute Kidney Injury. Front Pediatr. 2022 April 7;10:842544. doi: 10.3389/fped.2022.842544. PMID: 35463895; PMCID: PMC9021424

posure by 42%, a decrease in the rate of AKI by 78%, and decreased number of days with AKI by 68% (3)". By harnessing the power of information already readily available in the EMR, AI and ML models hold great promise in flagging these at-risk infants, thus helping to stave off AKI injury before it begins.

"Of note, many studies have reported the superiority of using biomarkers to predict AKI in pediatric patients and neonates as well. Future directions include the application of AI along with biomarkers (neutrophil gelatinase-associated lipcalin (NGAL), for example, in a Labelbox configuration to create a more robust and accurate model for predicting and detecting pediatric/neonatal AKI (3,4)."

Of note, many studies have reported the superiority of using biomarkers to predict AKI in pediatric patients and neonates as well. Future directions include the application of AI along with biomarkers (neutrophil gelatinase-associated lipcalin (NGAL), for example, in a Labelbox configuration to create a more robust and accurate model for predicting and detecting pediatric/neonatal AKI (3,4). AI and ML models may be able to take these biomarkers into account, in addition to other clinical predictors, in order to identify at-risk infants correctly.

Finally, methylxanthines, theophylline, and caffeine have demonstrated reno-protective effects by inhibiting adenosine-induced renal vasoconstriction, thereby preventing neonatal AKI (2). The thought is that if the AI or ML model predicts the possibility of the development of neonatal AKI in a patient, an EMR notification would appear, suggesting that possibility with a suggestion of using caffeine therapy to prevent the development of AKI. The same notification could be used for avoiding nephrotoxic medications (2,3).

There is a wealth of information in the EMR that *can* be used for the benefit of our patients; however, doing so can be cumbersome and inefficient. With the entry of AI and ML into the healthcare setting, the EMR can be leveraged in a much more simplified and accessible way such that it can be used to help guide real-time, informed, evidence-based medical decisions (7). The intersection of the EMR platform with AI makes for an inspiring time for health care, and we look forward to seeing how these translate into efficient and intuitive management workflows for clinicians in AKI and beyond.

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