

Otterbein University

Digital Commons @ Otterbein

Nursing Student Class Projects (Formerly MSN)

Student Research & Creative Work

2016

Pathophysiology of Sepsis Associated Acute Kidney Injury

Amanda M. Urban

Otterbein University, aurban@otterbein.edu

Follow this and additional works at: https://digitalcommons.otterbein.edu/stu_msn



Part of the [Nursing Commons](#)

Recommended Citation

Urban, Amanda M., "Pathophysiology of Sepsis Associated Acute Kidney Injury" (2016). *Nursing Student Class Projects (Formerly MSN)*. 175.

https://digitalcommons.otterbein.edu/stu_msn/175

This Project is brought to you for free and open access by the Student Research & Creative Work at Digital Commons @ Otterbein. It has been accepted for inclusion in Nursing Student Class Projects (Formerly MSN) by an authorized administrator of Digital Commons @ Otterbein. For more information, please contact digitalcommons07@otterbein.edu.

Pathophysiology of Sepsis-Associated Acute Kidney Injury

Amanda M Urban BSN, RN, OCN
Otterbein University, Westerville, Ohio



OTTERBEIN
UNIVERSITY

Introduction.

- 40% of critical care patients have AKI and about half of those patients are also suffering from sepsis (Pettilä & Bellomo, 2014)
- As a nurse on a progressive care medical oncology unit, sepsis patients are encountered on a daily basis and many of them are also diagnosed with AKI.
- Through research, the author hopes to gain a better understanding of the connection between AKI and sepsis.
- As a master's student studying to be a nurse practitioner, the author hopes to gain knowledge that can be applied to future practice.

Signs and Symptoms

According to Dirkes (2013) signs and symptoms of sepsis include fever greater than 38 degrees Celsius, heart rate greater than 90 beats/minute, respiratory rate greater than 20 breaths per minute, and leukocytosis greater than 12,000/mm³ or less than 4,000/mm³. Meeting 2 or more of four of the previous criteria qualifies for a diagnosis of systemic inflammatory response syndrome (SIRS). Diagnosis of sepsis occurs when a patient meets SIRS criteria and an infections source is determined or suspected. Signs of AKI include azotemia, elevated serum creatinine and blood urea nitrogen and low urine output (p. 125-126).

Older adults sometimes present with atypical signs of sepsis including confusion and agitation (Hain & Paixao, 2015).

Underlying Pathophysiology and Significance of Pathophysiology

Septic associated acute kidney injury involves alterations in microcirculation and impairment of normal hemostasis. According to Dirkes (2013) the initial injury causes endothelium to leak protein-rich fluid into the subcutaneous tissues, which then initiates an inflammatory response. Neutrophils respond and adhere to the endothelial cells in the injured area. The body activates catecholamines, which cause vasoconstriction and vasodilation. Amount of perfused capillaries is reduced and venules become clogged with neutrophils. This causes a cessation of blood flow and in turn leads to hypoxia of tissue (p. 126). According to Shum, Yan, and Chan (2015) when the venules are clogged it takes a long time for leukocytes to pass through which results in a longer exposure time of the endothelium to cytokine, and pathogens which then triggers more inflammatory signals and leads to more oxidative stress (p. 84). According to Dirkes (2013) this inflammation and endothelial injury leads to activation of coagulant system and causes a cycle of vascular injury and cell death. It has been discovered that when microcirculation is rapidly improved there is an increased chance for sepsis survival and improvement in organ function within 24 hours (p. 126). Venkatachalam and Weinberg (2012) describe this release of cytokines as a "cytokine storm" accompanied by peripheral vascular resistance and hypotension (p. 81). According to Alobaidi, Basu, Goldstein, and Bagshaw (2015) "cellular hypoxia is a molecular driver of injury during SA-AKI. Tissue hypoxia in the kidney during sepsis may be defined by inflammation, changes in intrarenal nitric oxide, nitrosative stress, or oxygen radical homeostasis and dysregulation (p. 6).



(Enzo Life Sciences, 2014)

According to Dirkes (2013) the septic response impairs homeostasis. Inflammation of the microcirculation is what alters homeostasis. The exposure of the endothelium to cytokines results in alterations of function. This can cause abnormal balance between vasoactive compounds (nitric oxide, prostacyclin), which leads to loss of vascular tone and microvascular perfusion heterogeneity. Circulatory disruption occurs including cellular debris occluding the vessel, which leads to production of cytokines and reactive oxygen species and causes an imbalance between procoagulant and anticoagulant mechanisms (p. 127).

According to Dirkes (2013) In the kidney, proinflammatory cytokines, tumor necrosis factor-alpha, and Interleukin-6 are generated by injured renal tubule cells or from extrarenal cells and are a contributor to renal injury. The influx of all of the inflammatory cytokines leads to congestion and therefore slows renal blood flow leading to AKI. If hypoperfusion of renal system persists, AKI progresses to structural tubular injury (p. 127.). Another study done by Xu, Chang, Hack, Eadon, Alper, and Cunningham (2013) looks at the pathological changes of the glomerular endothelium and found that tumor necrosis alpha plays a huge role in these changes (p. 79).

New Research

- Clinical trials based on molecular approaches have poor results.
- Current therapy is aimed at management of hemodynamics including administration of crystalloids (Schortgen & Asfar, 2015).
- Albumin is a second line therapy. (Schortgen & Asfar, 2015)
- Recommendations are to give fluid to maintain a mean arterial pressure (MAP) of 65-70. Trials keeping MAP 80-85 showed no decrease in mortality from trials keeping MAP 65-70 (Schortgen & Asfar, 2015).
- Early administration of antibiotics is associated with increased survival rates (Schortgen & Asfar, 2015).
- The alkaline phosphate is thought to neutralize bacterial endotoxins and catalyze the conversion of adenosine triphosphate into adenosine, a potent anti-inflammatory factor. This reduces inflammation and leads to decreased sepsis associated acute kidney injury (Swaminathan, Rosner, & Okusa, 2015).
- Alkaline phosphate administration phase 2a trials have been shown to reduce sepsis associated AKI (Swaminathan, Rosner, & Okusa, 2015).

Implications for Nursing Care

- There is still much to be discovered about sepsis associated acute kidney injury.
- Implications for nursing include recognition of SIRS criteria and initiation of current treatments including early antibiotic administration and fluid resuscitation
- Since mortality is such an issue with sepsis associated AKI, many clinical trials are currently underway which are sure to bring about upcoming change in clinical practice
- It is important for nurses of all levels to stay up to date on current research and practice related to this extremely prevalent critical care issue.

Conclusion

- Sepsis is a common cause of AKI.
- The research shows that AKI associated sepsis has high morbidity and mortality rates
- Even if a patient survives the acute phase of kidney injury there are many chronic consequences that can occur as a result.
- This makes keeping up with further research and developments related to AKI all the more important to nurses.

References

- Alobaidi, R., Basu, R. K., Goldstein, S. L., & Bagshaw, S. M. (2015). Sepsis-associated acute kidney injury. *Seminars In Nephrology*, 35(1), 2-11 10p. doi: 10.1016/j.semnephrol.2015.01.002
- Bonventre, J. V., & Yang, L. (2011). Cellular pathophysiology of ischemic acute kidney injury. *The Journal Of Clinical Investigation*, 121(11), 4210-4221. doi:10.1172/JCI45161
- Dirkes, S. (2013). Sepsis and Inflammation: Impact on Acute Kidney Injury. *Nephrology Nursing Journal*, 40(2), 125-132 8p.
- Hain, D., & Paixao, R. (2015). The Perfect Storm. *Critical Care Nursing Quarterly*, 38(3), 271-279 9p. doi:10.1097/CNQ.0000000000000070
- Pettilä, V., & Bellomo, R. (2014). Understanding acute kidney injury in sepsis. *Intensive Care Medicine*, 40(7), 1018-1020. doi:10.1007/s00134-014-3313-9
- Schortgen, F., & Asfar, P. (2015). Update in sepsis and acute kidney injury 2014. *American Journal Of Respiratory & Critical Care Medicine*, 191(11), 1226-1231 6p. doi:10.1164/rccm.201502-0307UP
- Shum, H., Yan, W., & Chan, T. M. (2016). Recent knowledge on the pathophysiology of septic acute kidney injury: A narrative review. *Journal Of Critical Care*, 31(1), 82-89. doi:10.1016/j.jcrc.2015.09.017
- Swaminathan, S., Rosner, M. H., & Okusa, M. D. (2015). Emerging therapeutic targets of sepsis-associated acute kidney injury. *Seminars In Nephrology*, 35(1), 38-54 17p. doi:10.1016/j.semnephrol.2015.01.005
- Venkatachalam, M. A., & Weinberg, J. M. (2012). The tubule pathology of septic acute kidney injury: A neglected area of research comes of age. *Kidney International*, 81(4), 338-340. doi: 10.1038/ki.2011.401
- Xu, C., Chang, A., Hack, B. K., Eadon, M. T., Alper, S. L., & Cunningham, P. N. (2014). TNF-mediated damage to glomerular endothelium is an important determinant of acute kidney injury in sepsis. *Kidney International*, 85(1), 72-81. doi:10.1038/ki.2013.286
- Additional Sources**
- AKI Main [Digital image]. (2014, January). Retrieved July 25, 2016, from <http://www.enzolifesciences.com/science-center/technotes/2014/january/better-monitoring-could-reduce-kidney-injury/>