

UROLOGY

UPMC DEPARTMENT OF UROLOGY

UPMC
LIFE CHANGING MEDICINE

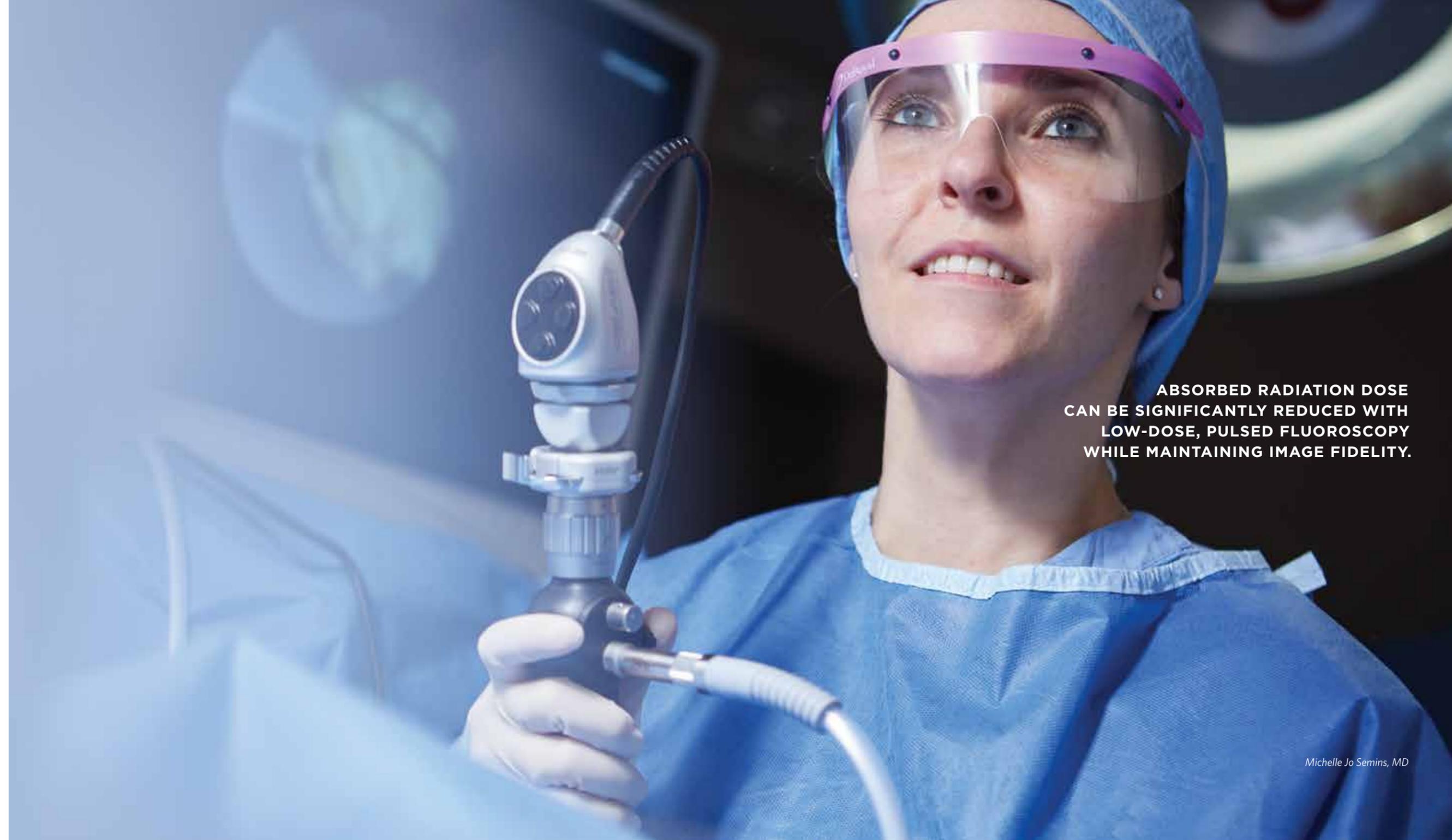
Radiation Exposure and Dose Reduction Research in Endourologic Procedures

Ionizing radiation exposure from fluoroscopy is and continues to be a significant concern for affected patients and all practicing endourologists, particularly those who operate in high-volume settings and in academic, teaching institutions. While annual radiation exposure limits for all workers are set and maintained by federal regulatory agencies, there currently exist no unified or consensus guidelines for how endourologists should protect themselves during fluoroscopy-guided procedures, and the prevalence of dosimeter usage by endourologists to routinely track exposure levels is relatively low.

Michelle Jo Semins, MD, assistant professor, and director of the UPMC Mercy Kidney Stone Clinic, first became interested in better understanding radiation exposure patterns for endourologists and how to minimize exposure for physicians, operating room team members, and patients in 2011 when she first joined the UPMC Department of Urology as a faculty member. Dr. Semins was periodically alerted to high ALARA levels during her first year at UPMC. "Transitioning to a teaching environment was one of the reasons for the higher levels I was getting. This caused me to begin to think about ways I could reduce my radiation exposure, and in turn it led me to actively study the problem given that virtually all of my cases over the course of my career are going to involve the use of radiation to one degree or another," says Dr. Semins.

One of Dr. Semins' first studies sought to better understand what radiation exposure patterns may look like, and how practicing endourologists in high-volume institutions typically protect themselves during procedures. This was followed by several studies beginning in 2013 that have examined the use of low-dose and pulsed fluoroscopy, and a combination of both to determine to what degree radiation exposure could be curtailed. Dr. Semins also has examined pulsed fluoroscopy and its relationship to fluoroscopy time in ureteroscopy and radiation exposure. "This is important for patients, too, given the fact that recurrent stone disease is a common occurrence, and these patients may need numerous procedures during their lives. Reducing their exposure levels and possible future complications is paramount as well," says Dr. Semins.

While her studies into radiation exposure are relatively new within her research portfolio, Dr. Semins has for some time researched and continues to investigate the management of kidney stones during pregnancy. She has authored numerous peer-reviewed papers, book chapters, reviews, and presentations on the topic.



ABSORBED RADIATION DOSE CAN BE SIGNIFICANTLY REDUCED WITH LOW-DOSE, PULSED FLUOROSCOPY WHILE MAINTAINING IMAGE FIDELITY.

Michelle Jo Semins, MD

Single Pulse-Per-Second Fluoroscopy and Radiation Exposure

The standard for continuous fluoroscopy is 30 pulses per second. However, most machines allow for some type of reduced pulse rate, in addition to a standard low-dose setting which in most cases reduces radiation exposure by approximately 60 percent. While a 60 percent reduction in radiation exposure through the low-dose setting is definitely preferable, Dr. Semins became intrigued about whether or not one could use both the low-dose setting and a pulsed setting together. Would this combination allow for usable image fidelity during procedures, and would it lead to an even further reduction in radiation exposure?

“Essentially, I just decided to try a single pulse per second, the lowest possible setting on our fluoroscope, combined with the low-dose setting, and it worked. With a single pulse-per-second, there is a degree of motion artifact if you try to simultaneously move the fluoroscope while engaging the foot pedal, but modulating my technique, speed, and use of the foot pedal eliminated the issue,” says Dr. Semins. Once Dr. Semins determined that she could still operate at these settings and maintain sufficient imaging clarity, the stage was set to formally begin to measure the effects of single-pulse-per-second procedures in comparison to the standard continuous low-dose method.

Dr. Semins at work in the UPMC Mercy Kidney Stone Clinic.



In 2017, Dr. Semins and colleagues published findings in the journal *Urology* from their recently completed study² using pulsed fluoroscopy in ureteroscopy. The study examined conventional continuous low-dose fluoroscopy versus one pulse-per-second low-dose fluoroscopy in adult ureteroscopy patients over a 12-month period. The conventional approach was used for the first six months of the study, followed by the pulsed method for the second six-month period. Dr. Semins sought to show how the reduced pulse rate affected fluoroscopy time during procedures, and how this might translate to a surgeon’s total exposure to ionizing radiation.

In summary, with single pulse-per-second fluoroscopy, the usage time decreased from a mean of 77 seconds to 16 seconds. This reduced fluoroscopy time translated into a combined 64 percent reduction in radiation exposure to the surgeon.

Dr. Semins and colleagues have finished a follow-up bench-top study similar in nature to the first retrospective analysis, showing an even larger radiation reduction potential with a combined one pulse-per-second low-dose fluoroscopy. The results of this study have been completed and submitted for publication, as well as having been presented at last year’s Northeastern Section American Urological Association meeting and the World Congress of Endourology 2017. Using a simulated patient model, 60-second timed exposures were made using various pulse rates (30, 8, 4, 2, 1) with and without the low-dose setting, while radiation exposure was captured with dosimeters placed in various proximities to the subject.

“We were able to confirm that the low-dose setting does correlate to a 60 percent reduction in radiation like we had thought, but during the 60-second exposures of this test, when combining low dose and the single pulse-per-second, actual radiation exposure decreased by 97 percent, which is shockingly high and has great implications for everyone in the operating room involved in these procedures, including the patient,” says Dr. Semins. She and the entire research team are excited to have these findings published in the near future, along with additional related work they have been involved with during the last five years.

Managing Kidney Stones During Pregnancy

A significant aspect of Dr. Semins’ research and clinical care is related to understanding kidney stone burden and optimal management procedures for women during pregnancy.⁷⁻¹³ “Kidney stones during pregnancy can be very problematic, both in terms of the diagnosis and management, given the specific risk factors and other considerations required with this patient population,” says Dr. Semins. With respect to diagnosis, ultrasound-based imaging has poor sensitivity, and CT scans are typically contraindicated because of radiation exposure to the developing fetus. Management is complicated for many reasons related to preserving the ongoing health of the mother and baby.

Certain aspects of a pregnancy account for a set of unique risk factors for kidney stone formation, and these may be exacerbated by other comorbidities in the general population such as obesity, diabetes, and metabolic syndrome. During pregnancy, glomerular filtration rate increases due to physiological changes, including cardiac output. Pregnant women also are prone to hypercalciuria as a result of gastrointestinal absorption and bone mobilization.

“Conservative management should typically be the first approach unless there are other mitigating factors that would necessitate surgical intervention. These could be related directly to complications arising from the stone or stones, or because of a woman’s underlying obstetrical complications,” says Dr. Semins.

References and Further Reading

For additional information about Dr. Semins' research into radiation exposure in endourologic procedures and the management of kidney stones during pregnancy, please see the selection of published papers below.

- 1 Dudley AG, Semins MJ. Radiation Practice Patterns and Exposure in the High-Volume Endourologist. *Urology*. 2015; 85(5): 1019-23.
- 2 Yecies T, Fombona A, Semins MJ. Single Pulse-Per-Second Setting Reduces Fluoroscopy Time During Ureteroscopy. *Urology*. 2017; 103: 63-67.
- 3 Wenzler DL, Abbot JE, Su JJ, Shi W, Slater R, Miller D, Semins MJ, Sur RL. Predictors of Radiation Exposure to Providers During Percutaneous Nephrolithotomy. *Urol Annl*. 2017; 9(1): 55-60.
- 4 Yecies T, Semins MJ, Chaudhry R. Identifying the Relationship Between Fluoroscopy Pulse Rate and Radiation Absorbed Dose. Presented at the Northeastern Section AUA, Savannah, Georgia and World Congress of Endourology 2017, Vancouver, Canada.
- 5 Yecies T, Averch TA, Semins MJ. Identifying and Managing the Risks of Medical Ionizing Radiation in Endourology. *CJU*. 2017; In press.
- 6 Yecies T, Semins MJ. Modeling the Incidence of Secondary Malignancy and Subsequent Mortality Related to Ionizing Radiation use in the Evaluation and Management of Nephrolithiasis, Presented at AUA 2018, San Francisco, California.
- 7 Semins MJ, Trock BJ, Matlaga Br. The Safety of Ureteroscopy During Pregnancy: A Systematic Review and Meta-Analysis. *J Urol*. 2009; 181(1): 139-143.
- 8 Semins MJ, Matlaga BR. Management of Urolithiasis During Pregnancy. *Int J Womens Health*. 2013; 5: 599-604.
- 9 Semins MJ, Matlaga BR. Kidney Stones During Pregnancy. *Nat Rev Urol*. 2014; 11(3): 163-8.
- 10 Riley JM, Dudley AG, Semins MJ. Nephrolithiasis and Pregnancy: Has the Incidence Been Rising? *J Endourol*. 2014; 28(3): 383-6.
- 11 Mullins JK, Semins MJ, Hyams ES, Bohlman ME, Matlaga BR. Half Fourier Single-Shot Turbo Spin-Echo Magnetic Resonance Urography for the Evaluation of Suspected Renal Colic in Pregnancy. *Urology*. 2012; 79(6): 1252-1255.
- 12 Semins MJ, Matlaga BR. Management of Stone Disease in Pregnancy. *Curr Opin Urol*. 2010; 20(2): 174-177.
- 13 Semins MJ, Matlaga BR. Ureteroscopy During Pregnancy. *Indian J Urol*. 2009; 25(3): 291-295.

UPMC Department of Urology Endourology Faculty



Timothy D. Averch, MD, FACS

*Professor and Vice Chair for Quality
Director of Endourology
Division Chief of Urology - UPMC Presbyterian
Chair, AUA Quality Improvement and
Patient Safety Committee*

Joel D. Bigley, MD

*Assistant Professor of Urology
Chief of Urology, VA Pittsburgh Healthcare System*

Stephen V. Jackman, MD

*Professor of Urology
Residency Director*

Michelle Jo Semins, MD

*Assistant Professor of Urology
Director, UPMC Mercy Kidney Stone Clinic*

A \$16 billion world-renowned health care provider and insurer, Pittsburgh-based UPMC is inventing new models of patient-centered, cost-effective, accountable care. UPMC provides more than \$900 million a year in benefits to its communities, including more care to the region's most vulnerable citizens than any other health care institution. The largest nongovernmental employer in Pennsylvania, UPMC integrates 80,000 employees, more than 30 hospitals, 600 doctors' offices and outpatient sites, and a 3.2 million-member Insurance Services Division, the largest medical insurer in western Pennsylvania. As UPMC works in close collaboration with the University of Pittsburgh Schools of the Health Sciences, *U.S. News & World Report* consistently ranks UPMC on its annual Honor Roll of America's Best Hospitals. UPMC Enterprises functions as the innovation and commercialization arm of UPMC, and UPMC International provides hands-on health care and management services with partners on four continents. For more information, go to UPMC.com.



200 Lothrop St.
Pittsburgh, PA 15213-2582

NON PROFIT ORG
US POSTAGE
PAID
PITTSBURGH, PA
PERMIT NO. 3834