Cardiac Stress Testing and the Radiotracer Supply Chain: Nuclear Freeze

Nearly 15 million doses of technetium Tc 99m ($^{99m}$Tc) are used annually in the United States, most of which for cardiac stress testing with single-photon emission computed tomography myocardial perfusion imaging (SPECT-MPI). Technetium Tc 99m is produced largely from "weapons-grade" highly enriched uranium (HEU). None of the nuclear reactors that produce molybdenum Mo 99 ($^{99}$Mo), the parent isotope of $^{99m}$Tc, are located in the United States and all are at least 50 years old, with repeated shortages of $^{99m}$Tc occurring owing to required repairs. Although widely discussed, the clinical implications of these shortages have not been well studied. If $^{99m}$Tc is unavailable, physicians may choose an older radiotracer, thallium Tl 201, or alternative tests. Such abrupt shifts could affect test quality and the use of downstream procedures including cardiac catheterization. We explored the clinical effects of a 6-month shortage (March-August 2010) for $^{99m}$Tc resulting from shutdowns of 2 major nuclear reactors.

A, The proportion of use of $^{99m}$Tc-labeled radiotracer among cardiac stress tests with single-photon emission computed tomography myocardial perfusion imaging (SPECT-MPI) shows a marked dip in mid-2010, corresponding to a period of severe disruptions in the worldwide $^{99m}$Tc supply chain. During this period, there was a corresponding increase in the rate of cardiac catheterizations within 90 days after SPECT-MPI. B, Rates of SPECT-MPI, computed tomography coronary angiography, stress echocardiography, and positron emission tomography-MPI during this period are shown.

Figure. Trends in Technetium Tc 99m ($^{99m}$Tc) Use and Cardiac Imaging for Evaluation of Coronary Artery Disease Among Medicare Beneficiaries Aged 65 Years or Older, 2008 to 2012
Methods | Using the 20% random sample of fee-for-service Medicare beneficiaries aged 65 years or older in the carrier and enrollment data from 2008 through 2012, we assessed 99mTc radiotracer use in the approximately 2 million cardiac stress tests with SPECT-MPI performed during these years, using codes A9500 and A9502 to identify 99mTc-labeled radiotracers. We calculated population-based rates of SPECT-MPI as well as rates for alternative testing modalities (stress echocardiography, computed tomography coronary angiography, and positron emission tomography–MPI) and downstream cardiac catheterization less than 90 days after index testing. We identified a priori the 6-month shortage during March through August 2010 due to shutdowns at the Petten High Flux and Chalk River Laboratories reactors, the 2 major producers of 99Mo for the United States. We used descriptive statistics to document temporal trends. Multivariable logistic regression was used to estimate the odds of cardiac catheterization less than 90 days after SPECT-MPI depending on radiotracer use after adjusting for age, sex, and race. This study was approved by the University of Michigan Institutional Review Board. Informed consent was waived for this retrospective study.

Results | During the shortage, 99mTc use fell nearly one-fourth from 64% of SPECT-MPI in February 2010 just prior to the shortage to a low point of 49% in May 2010 (Figure, A). Despite a partial rebound after the shortage, 99mTc use continued to decline, accounting for 52% of SPECT-MPI in September 2012. We observed steadily declining use of SPECT-MPI throughout the study period with stable rates of stress echocardiography, computed tomography coronary angiography, and positron emission tomography–MPI during the shortage (Figure, B). The adjusted odds of undergoing cardiac catheterization less than 90 days after SPECT-MPI was higher during the shortage (odds ratio = 1.09; 95% CI, 1.07-1.10; P < .001). Given the frequency of SPECT-MPI, 5715 excess cardiac catheterizations may have occurred among Medicare beneficiaries.

Discussion | Recent shortages of 99mTc were associated with major shifts in its use during cardiac stress testing and an increase in downstream cardiac catheterization. Although changing referral patterns could contribute, we did not observe meaningful deviations from long-term trends in use of SPECT-MPI or alternative imaging tests during the shortage. This is supported by data from a Canadian hospital where downstream testing during the shortage of 99mTc increased by 77% and radiation exposures to patients doubled.4 Our study extends this finding to the United States nationally and raises a new concern of decreasing 99mTc use overall. Thallium TI-201 is associated with higher radiation exposure4 and lower specificity relative to 99mTc.

Given tension between medical applications of HEU and potential for nuclear weapons proliferation, the US Congress authorized $143 million from 2011 to 2014 to encourage domestic production of 99mTc from sources other than HEU but has not renewed funding. Export of HEU fuel will be banned starting in 2020, which could severely curtail production of 99mTc. These converging pressures on the 99mTc supply chain have substantial clinical implications and underscore the importance of developing new production approaches and encouraging alternative testing approaches.

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Trends in Palliative Care Use in Veterans With Severe Heart Failure Using a Large National Cohort

Although palliative care (PC) improves quality of life in heart failure (HF),1-3 there is a paucity of data describing PC use in HF. The objective of this study was to describe trends in PC use in veterans with severe HF using a large national cohort.

Methods | We conducted a cross-sectional analysis of patients from fiscal years 2007 to 2013 using Veteran Affairs External Peer Review Program data. A detailed description of the Veteran Affairs External Peer Review Program has been previously published.4 The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) was used to select patients with a diagnosis of HF (codes 402.01, 402.11,