**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 $^{99m}$Tc radiotracer use in the approximately 2 million cardiac stress tests with SPECT-MPI performed during these years, using codes A9500 and A9502 to identify $^{99m}$Tc-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 $^{99m}$Mo 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, $^{99m}$Tc 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, $^{99m}$Tc 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 $^{99m}$Tc 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 $^{99m}$Tc increased by 77% and radiation exposures to patients doubled.3 Our study extends this finding to the United States nationally and raises a new concern of decreasing $^{99m}$Tc use overall. Thallium TI 201 is associated with higher radiation exposure4 and lower specificity relative to $^{99m}$Tc.

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 $^{99m}$Tc 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 $^{99m}$Tc. These converging pressures on the $^{99m}$Tc 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,
Results | Over the 7-year period, 4474 patients with severe HF were identified. Among these patients, 7.6% (338 of 4474) were seen by PC. Compared with patients not seen by PC, those seen by PC were similar in age (mean [SD] age, 83.6 [6.4] vs 81.8 [6.2] years), were equally likely to be male (98.8% [334 of 338] vs 99.1% [4097 of 4136]), had a higher mean (SD) brain-type natriuretic peptide level (5260 [12622] vs 4213 [8496] pg/mL), and had a similar percentage with left ventricular ejection fraction of less than 35% (44.7% [142 of 318] vs 46.7% [1790 of 3830]). Patients seen by PC had the following comorbidities coded in the prior 2 years: hypertension (93.2% [315 of 338]), chronic obstructive pulmonary disease (45.0% [152 of 338]), diabetes (48.5% [164 of 338]), cerebrovascular accident (29.9% [101 of 338]), malignancy (30.2% [102 of 338]), and acute myocardial infarction (26.6% [90 of 338]).

There was a significant trend toward increased PC use over time (Figure). Overall, 51.2% (2292 of 4474) of patients with HF died within 1 year of hospitalization. Those who died were more likely to have been seen by PC (10.7% [246 of 2292] vs 4.2% [92 of 2182], P < .001). Those seen by PC had a 1-year mor-

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