cant decreases in blood pressure following renal denervation, but this sham-controlled study identified no such benefit. While these findings also may be influenced by patient selection, they should concern those inclined to recommend interventional treatment of resistant hypertension presumed due to renovascular causes. Keeping in mind that blood pressure reduction can only be considered a surrogate for “hard end points” such as death, myocardial infarction, stroke, congestive heart failure, and renal failure, we seem to be very far removed from any convincing evidence that renal artery interventions reduce cardiovascular or renal morbidity or mortality.

With these issues in mind, where do we go from here? While awaiting further studies to investigate the possibility of a clinical benefit to renal artery interventions, we must focus on aggressive medical management of patients with refractory hypertension. We should not overlook the consistent evidence that sodium restriction, increased potassium intake, exercise and weight loss are associated with blood pressure reduction in patients with hypertension. Furthermore, the recent Eighth Joint National Committee guidelines suggest that for nonblack patients, first-line therapy for hypertension should consist of 1 or a combination of thiazide diuretics, calcium channel blockers, angiotensin-converting enzyme inhibitors and angiotensin receptor blockers. For black patients, first-line therapy should consist of thiazide diuretics and calcium channel blockers. Emphasis on the importance of lifestyle measures and medication compliance, and consideration of secondary causes such as sleep apnea, drug-induced hypertension, hypercortisolism, hyperaldosteronism, hyperthyroidism or hypothyroidism, or hyperparathyroidism is warranted in patients with resistant hypertension. Focus on proven therapies while we await more concrete data supporting the use of interventional procedures for resistant hypertension is the most reasonable approach, at least until the next big thing comes along.

David M. Safley, MD
Adnan K. Chhatriwalla, MD

Author Affiliations: Saint Luke’s Mid America Heart Institute, Kansas City, Missouri; University of Missouri–Kansas City, Kansas City.

Corresponding Author: Adnan K. Chhatriwalla, MD, Saint Luke’s Mid America Heart Institute, 4300 Wornall Rd, Ste 2000, Kansas City, MO 64111 (achhatriwalla@saaint-lukes.org).


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LESS IS MORE
Altering Overuse of Cardiac Telemetry in Non–Intensive Care Unit Settings by Hardwiring the Use of American Heart Association Guidelines

Arrhythmia detection is reported to affect the clinical management of care in 3.4% to 12.7% of patients.1 The American Heart Association’s (AHA’s)2 published recommendations addressing the use of non–intensive care unit (non-ICU) cardiac telemetry stratify patients into 3 categories: cardiac telemetry is indicated, may provide benefit, or is unlikely to provide benefit. Clinical-effectiveness studies of implementing these guidelines have either reported the use of labor-intensive strategies3 or nonsustained decreases in non-ICU cardiac telemetry use.4 Various efforts to reduce the perceived overuse of cardiac telemetry at Christiana Care Health System, a 1100-bed tertiary care system, were unsuccessful. In August 2012 we convened a team to increase the appropriate use of non-ICU cardiac telemetry through the integration of AHA guidelines into our electronic ordering system (EOS). This effort was validated in March 2013 when non-ICU use of cardiac telemetry appeared on the Society of Hospital Medicine’s top 5 list for the Choosing Wisely campaign.5

Methods | Approval for this study was received from the institutional review board of Christiana Healthcare System; need for patient consent was waived. Our interdisciplinary team re-designed and standardized all cardiac telemetry orders within our EOS. Cardiac telemetry orders were removed from order sets for clinical conditions for which monitoring was not supported by the AHA guidelines.6 The remaining orders for cardiac telemetry required providers to select from a list of clinical indications, each with its AHA guideline–based predetermined telemetry duration (Box). bedside nurse assessment guidelines were embedded in the EOS to facilitate safe, timely, and automatic discontinuation of cardiac telemetry. When telemetry discontinuation was believed to be unsafe, such as in a patient with unstable blood pressure, the nurse was required to contact the physician, and telemetry could be reordered when appropriate.
We calculated total costs (direct and indirect) for the delivery of non-ICU telemetry. Time-motion studies were conducted to measure the nondirect patient care nursing time spent on telemetry-related tasks.

The study period began December 31, 2012, and ended August 12, 2013. The redesigned telemetry orders went into effect on March 18, 2013; there were 11 and 22 weeks in the pre-implementation and postimplementation periods, respectively.

In non-ICU patients 18 years or older, we measured the mean weekly number of patients with telemetry orders, the mean duration of telemetry, and the numbers of rapid response activations, codes, and deaths.

**Results** | Implementation of the revised telemetry order sets resulted in an immediate and sustained reduction in the mean (SD) weekly number of telemetry orders from 1032.3 (32.1) to 764.4 (32.1).

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**Figure. Control Charts of Non–Intensive Care Unit (ICU) Use of Cardiac Telemetry Before and After Implementation of Electronic Ordering System (EOS) Guidelines**

**A**

- January 10, 2013: E-mail request for application of diagnosis-specific AHA guidelines
- March 18, 2013: Launch week of EOS non-ICU telemetry orders based on AHA guidelines

**B**

- January 10, 2013: E-mail request for application of diagnosis-specific AHA guidelines
- March 18, 2013: Launch week of EOS non-ICU telemetry orders based on AHA guidelines

No. of Telemetry Orders per Week

Telemetry Duration per Patient, h

AHA indicates American Heart Association; brown lines, mean values; and horizontal shaded bars, upper and lower control limits (corresponding to 3 SDs).
593.2 (21.3), and the mean duration of telemetry fell from 57.8 (2.4) to 30.9 (0.9) hours (reductions of 43% and 47%, respectively; P < .001) (Figure). The mean number of patients monitored with telemetry decreased 70%, from 357.5 (20.6) to 109.1 (4.3). Hospital census, code blue, mortality, and rapid response team activation rates were stable throughout the observation period. Nurses spent a mean of 19.75 minutes per patient on telemetry-related tasks daily (>115 hours system wide). The estimated total daily cost to deliver telemetry was $53.44 per telemetry patient; thus, our mean daily cost for non-ICU cardiac telemetry decreased from $18 971 to $5772.

Discussion | Although overuse of cardiac telemetry in non-ICU settings is widely recognized, there is a paucity of literature outlining successful and safe strategies addressing this concern. Our project led to a sustained 70% reduction in telemetry use without adversely affecting patient safety. In fact, patient safety may be enhanced by reducing the potential for alarm fatigue and provider workflow interruption. This initiative's key success factors included the algorithm's simplicity and focus on appropriateness, an interprofessional frontline team creating improvements for relevant disciplines, and “hardwiring” national guidelines into our EOS. This intervention is estimated to save our organization $4.8 million annually, suggesting that efforts addressing opportunities listed in the Choosing Wisely campaign can be an effective strategy to enhance value-added health care.

Robert Dressler, MD, MBA
Marylou M. Dryer, MD, CMQ
Christian Coletti, MD
Donna Mahoney, MHICDS, CPHQ
Andrew J. Doorey, MD

Author Affiliations: Department of Medicine, Christiana Care Health System, Newark, Delaware (Dressler, Dryer, Coletti, Doorey); Value Institute, Christiana Care Health System, Newark, Delaware (Dressler, Dryer, Coletti, Mahoney, Doorey); Department of Data Acquisition and Measurement, Christiana Care Health System, Newark, Delaware (Mahoney).

Corresponding Author: Robert Dressler, MD, MBA, Department of Medicine, Christiana Care Health System, Room 2C50, 4755 Ogletown-Stanton Rd, PO Box 6001, Newark, DE 19718 (rdressler@christianacare.org).


Author Contributions: Ms Mahoney had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Dressler, Dryer, Coletti, Doorey. Acquisition, analysis, or interpretation of data: All authors. Drafting of the manuscript: Dressler, Dryer. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Dressler, Dryer, Mahoney. Administrative, technical, or material support: Dressler, Dryer, Coletti, Mahoney. Study supervision: Dressler, Doorey.

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A Call for Evidence-Based Telemetry Monitoring: The Beep Goes On

Technology evolves quickly; scientific evidence builds slowly. This is as true for inpatient cardiac telemetry monitoring as it is for other medical interventions. Telemetry was invented in 1949 and saw widespread use in the 1960s for detecting arrhythmias in patients with myocardial infarction. Today the use of telemetry is ubiquitous on medical and surgical wards, often for patients without active cardiac conditions.

The Choosing Wisely campaign advocates the use of a protocol to govern the continuation of telemetry monitoring and cites the 2004 American Heart Association (AHA) guidelines for suggestions on appropriate telemetry use. However, no randomized trial evaluating telemetry monitoring has been reported; thus, the evidence is observational. Large studies in the early reperfusion era showed that the rates of arrhythmia are low. In patients hospitalized with acute coronary syndrome, one study found that the rate of malignant arrhythmias (sustained ventricular tachycardia, ventricular fibrillation, asystole, and torsades de pointes) in the first 21 hours of presentation was less than 1%. One large study also examined clinical outcomes. The authors observed 2240 patients admitted to a non–intensive care unit (ICU) telemetry unit and found that only 0.8% of the patients were transferred to the ICU because of an arrhythmia and, of the 0.9% of patients who died, half had do-not-resuscitate orders. The authors concluded that “the role of telemetry in guiding patient management may be overestimated by physicians.” Certainly, the use of monitoring until the moment a patient is discharged is clinically irrational: monitoring should be time limited.

Most important, the AHA guidelines do not offer recommendations for the use of monitoring in noncardiac conditions outside the ICU. The widespread use of telemetry in these conditions, such as acute pulmonary embolism or sepsis, demonstrates a large oversight in evidence-based practice because evidence is nearly absent. A rare exception was a recent study that demonstrated a 4.4% incidence of new-onset atrial fibrillation for non-ICU patients with sepsis. Of course, atrial fibrillation can be detected on physical examination or routine measurement of vital signs. This is a recurring issue in studies of telemetry: just because an arrhythmia is found on telemetry does not mean that telemetry was needed to find it. In addition, not every arrhythmia is clinically meaningful.

Against this backdrop of potential overuse, the study by Dressler et al in this issue of JAMA Internal Medicine set limits on telemetry monitoring outside the ICU based on the AHA guidelines. The authors incorporated the guidelines into their inpatient electronic ordering system by limiting the acceptance of monitoring and setting limits on the duration based on the indication provided. The mean daily number of patients monitored with telemetry fell by 70%, the mean duration of monitoring dropped by 47%, and both of these results occurred with no significant increase in code blue or rapid-response calls. The authors also estimated that they reduced the daily cost of telemetry monitoring by $13 199. This cost calculation is, of course, institution specific and cannot account for the secondary costs that underlie unnecessary monitoring: workup of clinically meaningless events, such as sinus bradycardia during sleep; decreased patient mobility owing to attached equipment; and reduced hospital throughput as patients wait for telemetry-capable beds.

It is remarkable to achieve such a substantial reduction in the use of this resource without significantly increased adverse outcomes. This result suggests 2 conclusions. First, telemetry is overused, and the AHA guidelines, imperfect as they may be, can safely rein in unnecessary monitoring. Second, since the guidelines exclude patients who do not have a primary cardiac condition, the intervention must have safely reduced or nearly eliminated monitoring for these patients. It is a reminder of the absence of known clinical benefit of using telemetry on medical and surgical services. To practice evidence-based care, we need a randomized trial of telemetry.

I often ask house staff on the medicine service to think about what is more helpful in the first 24 hours of a patient’s hospitalization for bleeding or sepsis: heart rhythm monitoring or more-frequent measurement of vital signs. They invariably acknowledge that the former is not a replacement for the latter, although this is unfortunately the perception and practice.

We are entering an era of unprecedented technological advancement in medicine. Unfortunately, technology often overtakes scientific evidence in the race to the bedside. We must remain vigilant against this outcome in the name of patient safety and cost.

Nader Najafi, MD

Author Affiliation: Division of Hospital Medicine, University of California, San Francisco.

Corresponding Author: Nader Najafi, MD, Division of Hospital Medicine, University of California, San Francisco, 505 Parnassus Ave, Box 0131, San Francisco, CA 94143 (nader.najafi@ucsf.edu).


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National Use of Proton Pump Inhibitors From 2007 to 2011

Proton pump inhibitors (PPIs) are a class of therapeutically equivalent medications when used at equivalent doses.\(^1,2\) Despite this, high-cost PPIs continue to be used when low-cost equivalents are available. We sought to estimate the national loss associated with the use of high-cost PPIs over their lower-cost alternatives. Furthermore, we investigated the sociodemographic factors associated with the use of high-cost PPIs.

Methods | The 2007-2011 Medical Expenditure Panel Survey (MEPS), a nationally representative survey of the US noninstitutionalized civilian population provided by the Agency for Healthcare Quality and Research (AHRQ), was used for the analysis. The MEPS uses a complex survey design involving 5 interviews over 2 years with 2 overlapping cohorts and includes demographics, expenditures by payer and type, self-reported medical conditions, insurance coverage, and prescription drug information. The survey’s drug data have been found to be valid, especially among chronic medications, and not biased by sociodemographic variables.\(^3\)

Expenditures, both total and out-of-pocket, and total number of doses were secured across 6 PPIs—esomeprazole, omeprazole, lansoprazole, pantoprazole, rabeprazole, and dexlansoprazole. Omeprazole was classified as low-cost throughout the study period. Pantoprazole was classified as high-cost until it became a generic in 2011. The remaining PPIs were classified as high-cost. Any expenditure for a high-cost PPI resulted in the individual being classified as high-cost. Excess expenditure of high-cost PPIs was determined by individual PPI by year on a per-dose basis.

A logistic regression comparing low- or high-cost PPI users was created across sex, age (per 10 years), region (Northeast, Midwest, West, and South), metropolitan area, modified Elixhauser Comorbidity index, poverty category (poor, near-poor, low-income, middle-income, and high-income), highest degree (no high school, high school/General Education Development [GED], or more than high school), insurance status (any private, public, or uninsured), and race/ethnicity (white, black, Hispanic, or other). Complex survey weighting was included in all analyses and expenditures were standardized on 2011 dollars. Analysis was conducted using Stata statistical software (version 13; StataCorp) and included the recoding of 1 omeprazole expense outlier down to the 95th percentile and conservatively estimated to 360 doses. The study was judged to be exempt by the Ohio State University institutional review board.

Results | The study included 169,044 individuals, of whom 9463 were classified as PPI users. A total of 5166 individuals were classified as users of high-cost PPIs vs 4297 who were low-cost PPI users. As indicated in Table 1, low-cost PPI expenditures totaled $15.5 billion (95% CI, $13.8-$17.1 billion) compared with $63.4 billion (95% CI, $58.8-$68.1 billion) for high-cost PPIs. Use of high-cost PPIs resulted in $47.1 billion (95% CI, $43.6-$50.7 billion) in excess expenditure, of which esomeprazole accounted for $26.5 billion (95% CI, $23.8-$29.2 billion). In total, $6.69 billion (95% CI, $5.95-$7.43 billion) was excess in out-of-pocket costs paid by the users. The analysis found increased use of high-cost PPIs according to decreasing age, female sex, private insurance, region (Northeast or South), an Elixhauser index of 0, and the highest income category. Table 2 presents both bivariate and multivariate analyses.

### Table 1. Expenditures by High- and Low-Cost Proton Pump Inhibitors (PPIs)*

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-cost PPIs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total expenditure</td>
<td>14.4 (0.77)</td>
<td>15.1 (0.83)</td>
<td>13.7 (0.73)</td>
<td>11.5 (0.71)</td>
<td>8.74 (0.69)</td>
<td>63.4 (2.37)</td>
</tr>
<tr>
<td>Total doses</td>
<td>3.01 (0.16)</td>
<td>2.98 (0.15)</td>
<td>2.79 (0.15)</td>
<td>2.56 (0.15)</td>
<td>1.72 (0.13)</td>
<td>13.0 (0.48)</td>
</tr>
<tr>
<td>Price per dose, mean, $</td>
<td>4.80 (0.05)</td>
<td>5.06 (0.06)</td>
<td>4.91 (0.09)</td>
<td>4.50 (0.09)</td>
<td>5.08 (0.11)</td>
<td>4.86 (0.04)</td>
</tr>
<tr>
<td>Self-pay per dose, $</td>
<td>1.01 (0.05)</td>
<td>0.93 (0.05)</td>
<td>0.65 (0.04)</td>
<td>0.55 (0.03)</td>
<td>0.67 (0.05)</td>
<td>0.78 (0.02)</td>
</tr>
<tr>
<td><strong>Low-cost PPIs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total expenditure, $</td>
<td>2.49 (0.19)</td>
<td>2.88 (0.27)</td>
<td>2.76 (0.18)</td>
<td>3.56 (0.43)</td>
<td>3.77 (0.40)</td>
<td>15.5 (0.83)</td>
</tr>
<tr>
<td>Total doses</td>
<td>1.71 (0.11)</td>
<td>2.22 (0.14)</td>
<td>2.29 (0.13)</td>
<td>2.97 (0.17)</td>
<td>3.27 (0.20)</td>
<td>12.5 (0.48)</td>
</tr>
<tr>
<td>Price per dose, mean, $</td>
<td>1.47 (0.09)</td>
<td>1.25 (0.10)</td>
<td>1.13 (0.05)</td>
<td>1.18 (0.14)</td>
<td>1.09 (0.10)</td>
<td>1.20 (0.05)</td>
</tr>
<tr>
<td>Self-pay per dose, $</td>
<td>0.31 (0.05)</td>
<td>0.33 (0.07)</td>
<td>0.24 (0.02)</td>
<td>0.23 (0.02)</td>
<td>0.20 (0.02)</td>
<td>0.25 (0.02)</td>
</tr>
<tr>
<td>Total excess, $</td>
<td>10.0 (0.54)</td>
<td>11.2 (0.64)</td>
<td>10.3 (0.56)</td>
<td>8.43 (0.54)</td>
<td>7.10 (0.57)</td>
<td>47.1 (1.81)</td>
</tr>
<tr>
<td>Total excess in self-cost</td>
<td>2.11 (0.17)</td>
<td>1.79 (0.19)</td>
<td>1.15 (0.12)</td>
<td>0.84 (0.09)</td>
<td>0.80 (0.09)</td>
<td>6.69 (0.38)</td>
</tr>
</tbody>
</table>

Abbreviation: SE, standard error.

* Esomeprazole, rabeprazole, lansoprazole, and dexlansoprazole were identified as high-cost. Omeprazole was considered low-cost. Pantoprazole was considered high-cost from 2007 to 2010 and low-cost in 2011. Total excess and total excess in self-cost were determined on a per-dose basis using complex survey weighting.