Supplementary Online Content


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This supplementary material has been provided by the authors to give readers additional information about their work.
eAppendix 1. Current Procedural Terminology (CPT) and International Classification of Diseases, Ninth Revision (ICD-9) codes used to identify ICDs

<table>
<thead>
<tr>
<th>Variable</th>
<th>CPT codes</th>
<th>ICD-9 codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICD insertion</td>
<td>33240, 33245, 33246, 33249</td>
<td>37.94, 00.51</td>
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<tr>
<td>ICD monitoring</td>
<td>93640, 93641, 93642, 93737, 93738, 93741, 93742, 93743, 93744, 93282, 93283, 93284, 93287, 93289, 93295, 93296, 93290, 93297, 93299</td>
<td>89.49</td>
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<td>ICD revision</td>
<td>33223</td>
<td>37.79</td>
</tr>
<tr>
<td>ICD removal</td>
<td>33241, 33243, 33244</td>
<td></td>
</tr>
<tr>
<td>ICD partial insertion or replacement</td>
<td></td>
<td>37.95, 37.96, 37.97, 37.98, 00.54</td>
</tr>
</tbody>
</table>
eAppendix 2. Covariates entered into the multivariable model examining factors associated with ICD implantation within 1 year post-MI

- Age
- Sex
- Race
- Body mass index
- Current/recent smoker
- Diabetes
- Prior MI
- Prior PCI
- Prior CABG
- Prior heart failure
- Prior stroke
- Prior atrial fibrillation or flutter*
- Prior valvular disease*
- Prior cancer history*
- End stage renal disease (on dialysis or creatinine clearance < 30 among non-dialysis patients)
- Transferred in from another hospital
- Teaching hospital (membership in the Council of Teaching Hospitals)
- STEMI vs. NSTEMI presentation
- PCI performed during the index admission
- CABG performed during the index admission
- Signs and symptoms of cardiogenic shock during the index admission
- Ventricular tachycardia or fibrillation during the index admission*
- Peak troponin level
- Beta blocker at discharge
- ACE-inhibitor or ARB at discharge
- Aldosterone antagonist at discharge
- First cardiology follow-up visit within 2 weeks post-index discharge*
- Readmission for MI post-index discharge (time-dependent covariate)*
- Readmission for heart failure post-index discharge (time-dependent covariate)*

*variable obtained from Medicare claims data, all other variables obtained from ACTION Registry-GWTG data collection form.

MI = myocardial infarction, PCI = percutaneous coronary intervention CABG = coronary artery bypass graft, STEMI= ST-segment elevation myocardial infarction, ACE= angiotensin-converting enzyme, ARB= angiotensin receptor blocker
eAppendix 3. Detailed methodology description of the hierarchical logistic regression model

In Figure 1, we report the estimated distribution of hospital-specific 1-year ICD implantation rates rather than a histogram of raw site-specific proportions. Specifically, a hierarchical logistic regression model was used for estimating the distribution of hospital rates of 1-year ICD implantation after subtracting out the effect of random sampling variation. The log-odds for random hospital are assumed to be normally distributed with mean equal to the intercept and variance equal to the random effect variance. This describes the standard logistic hierarchical model. We estimated these parameters from the unadjusted model and transformed from the log-odds scale to the probability scale. Because this calculation is based directly on the estimated random effect variance, it provides a portrait of hospital variation that is neither excessively variable nor overshrunk. This approach provides a distribution of hospital-specific rates that is unbiased as long as hospital variation is normally distributed on the logit scale. This is a reasonable assumption made in nearly all applications of hierarchical models. However, if this assumption does not hold, the estimate of hospital variation will still be unbiased, only the illustration of variation as normally distributed may be inaccurate. In addition, we adjusted for patient-level covariates, i.e. potential differences in case mix between hospitals. This was achieved by including patient-level factors in the model as fixed effects. There are multiple ways to obtain a distribution of adjusted hospital rates. We simply replaced the random effect variance with new estimates based on the adjusted models. We have compared this approach to other more complicated methods and observed nearly identical results. Previous examples of this methodology are:


In order to avoid overstating the hospital variation, we used the hierarchical model to estimate the distribution of hospital-specific proportion of patients receiving ICDs within 1 year with unbiased variance. The raw site-specific histogram is statistically over-dispersed due to the fact that it is a plot of numerous sample proportions, each of which include large sampling error (particularly at small sites). The problem is that the proportion of patients receiving an ICD within 1 year, out of a sample of 5 patients for example, is not a good representation of the actual hospital proportion. This can also be seen in our data by progressively excluding smaller sites, which progressively reduces the extent of sampling error (see figures below). The histogram of sites with more than 40 patients looks similar to the estimated distribution, although it results in the exclusion of almost three-fourths of our sites and still includes some over-dispersion.

Histogram of hospital-level proportion of patients receiving ICD, excluding sites with fewer than 10 patients (n=242 hospitals):
Histogram of hospital-level proportion of patients receiving ICD, excluding sites with fewer than 25 patients (n=123 hospitals):

Histogram of hospital-level proportion of patients receiving ICD, excluding sites with fewer than 40 patients (n=75 hospitals):

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eAppendix 4. Covariates used in the multivariable model examining mortality risk

Age
Sex
Race
Body mass index
Current/recent smoker
Diabetes
Hyperlipidemia
Hypertension
Prior MI
Prior PCI
Prior CABG
Prior heart failure
Prior stroke
Prior atrial fibrillation or flutter*
Peripheral arterial disease
Prior valvular disease*
Prior cancer history*
STEMI vs. NSTEMI presentation
Heart rate on presentation
Systolic blood pressure on presentation
Signs of heart failure on presentation
Creatinine level on presentation
Hemoglobin level on presentation
PCI performed during the index admission
CABG performed during the index admission
Signs and symptoms of cardiogenic shock during the index admission
Ventricular tachycardia or fibrillation during the index admission*
Peak troponin level
Aspirin at discharge
Thienopyridine at discharge
Beta blocker at discharge
ACE-inhibitor or ARB at discharge
Aldosterone antagonist at discharge
Statin at discharge
Readmission for MI post-index discharge (time-dependent covariate)*
Readmission for heart failure post-index discharge (time-dependent covariate)*

*variable obtained from Medicare claims data, all other variables obtained from ACTION Registry-GWTG data collection form.

MI = myocardial infarction, PCI = percutaneous coronary intervention CABG = coronary artery bypass graft, STEMI= ST-segment elevation myocardial infarction, ACE= angiotensin-converting enzyme, ARB= angiotensin receptor blocker
eAppendix 5. Distribution of propensity scores for patients who did and did not receive an ICD within 1 year of MI

The x-axis represents the range of propensity scores observed in our sample. The y-axis represents the distribution density. The area between two points on the x-axis represents the proportion of patients falling into the indicated range. The range of possible propensity scores is from 0 to 1, but the graph extends below 0 because of the smoothing function that was used to generate the figure.