screening test. In 2012, the US Preventive Services Task Force recommended against routine PSA screening, citing a lack of evidence regarding its benefits and known harms from prostate biopsy and overtreatment of indolent prostate cancer.1

In this issue of JAMA Internal Medicine, Zavaski et al2 report that since the release of the US Preventive Services Task Force statement, the rate of PSA testing has declined overall but still is performed more frequently for patients receiving PSA testing for preventive health reasons through their urologist rather than through their primary care physician. The vast majority of PSA testing is still performed by primary care physicians, but there seems to be a continued perception, more firmly held by urologists than by primary care physicians, that the screening is beneficial. Urologists may hold this belief because they have referred more men who request PSA testing or because they have seen more poor outcomes from metastatic prostate cancer. Regardless, recent data show some decline in the detection of early-stage prostate cancer, which likely reflects decreased ordering of PSA tests, and hopefully indicates avoidance of harms of cancer treatment, such as erectile dysfunction and urinary incontinence.3 We will need to await data on rates of metastatic disease and prostate cancer deaths to understand the full effect of less PSA testing. To our knowledge, such data were not available 30 years ago when the PSA blood test became available. The American Urologic Association Quality Registry was developed in 2014 to better track prostate cancer care and should produce the type of information our patients deserve.4

In the meantime, recommendations to reduce PSA screening will only strengthen with release of a Healthcare Effectiveness Data and Information Set measure5 targeting the elimination of PSA screening in men older than 70 years. It is essential that, along with improved collection of outcomes data, we also have outcomes data on the myriad novel diagnostic and risk stratification tools rapidly becoming available, such as magnetic resonance imaging or ultrasound fused-guided prostate biopsy and genomic testing. Without such evidence, we can be sure that differing entrenched beliefs between urologists and primary care physicians will only become more expensive. Meanwhile, the widespread reuse of the PSA test should serve as a cautionary tale of the importance of first establishing that benefit exceeds harms before recommending new cancer screening tests.

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Conflict of Interest Disclosures: None reported.


LESS IS MORE

Variations in Peripherally Inserted Central Catheter Use and Outcomes in Michigan Hospitals

Use of peripherally inserted central catheters (PICCs) has grown substantially in hospitalized medical patients.1,2 However, data regarding PICC placement largely originate from single-center experiences or studies of highly select populations and outcomes.3 Consequently, little is known about variation in PICC use or outcomes across hospitals. To examine this, we conducted a prospective study at 10 hospitals through the Michigan Hospital Medicine Safety (HMS) Consortium, a quality-improvement initiative dedicated to preventing adverse events in hospitalized medical patients.

Methods | The design and sampling strategy of HMS have been previously described.4,5 Between December 1, 2013, and January 30, 2015, trained data abstractors at 1 of 10 participating HMS hospitals collected information including history and laboratory and medication data from patients who received PICCs in intensive care unit (ICU) and non-ICU settings. Information related to PICCs (eg, indication, gauge, number of lumens) was obtained from vascular nursing or interventional radiology insertion records. All patients were followed until PICC removal or 60 days after PICC insertion, whichever occurred first. Major PICC complications were defined as central line–associated bloodstream infection and symptomatic venous thromboembolism, whereas minor complications included mechanical problems (migration, kinking), catheter occlusion, exit-site infection, and thrombophlebitis. All outcomes were ascertained by medical record review, telephone follow-up, or both, which occurred at 14, 30, and 60 days after PICC placement. Indication for PICC insertion, dwell time, device characteristics, and complications were tabulated using descriptive statistics. PICC use rates for each hospital were estimated by expressing the proportion of PICCs placed in adult nonsurgical patients to the total number of nonsurgical adult discharges during the study period. Multilevel mixed-effects and logit models were then fitted to examine hospital-level differences in PICC use and complications. The study was classified as having a “not regulated” status from the institutional review boards at all of the participating hospitals. Therefore, patient consent was not required, and all data were deidentified.

Results | Data on 3378 PICCs placed in 3201 patients were available. Most PICCs (2406 [71.2%]) were placed by vascular access nurses and were double-lumen devices (1784 [52.8%]). Although the median dwell time for PICCs across hospitals was 10 days (range, 1 to >60 days), 817 PICCs (24.2%) were removed within 5 days of insertion. The most common indications for PICC insertion were difficult venous access (1387 [41.1%]) and home antibiotics (971 [28.7%]) (Figure).
APICC-related complication occurred in 646 cases (19.1%). Catheter occlusion was the most frequent complication, occurring in 340 cases (10.1%) (Table). Symptomatic deep vein thrombosis and pulmonary embolism occurred in 177 (5.2%) cases and were more frequent in patients in the ICU compared with non–ICU settings (65 [6.3%] vs 112 [4.8%], respectively; \( P = .06 \)). Although central line-associated bloodstream infection was documented in only 38 cases (1.1%), PICCs were frequently removed by physicians for suspected central line-associated bloodstream infection (63 cases [1.9%]).

The absolute volume of PICC use across the participating hospitals during the study period ranged from 73 to 479 devices, with corresponding user ratios of 2.5% to 8.2% \( (P < .001) \).

Variation in PICC use was not explained by underlying severity

![Figure. Variation in Volume and Indications for Peripherally Inserted Central Catheter (PICC) Placement by Hospital](image)

<table>
<thead>
<tr>
<th>Site No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICCs placed, No.</td>
<td>101</td>
<td>275</td>
<td>577</td>
<td>883</td>
<td>999</td>
<td>1812</td>
<td>1717</td>
<td>3758</td>
<td>2857</td>
<td>2240</td>
</tr>
<tr>
<td>PICC use rate, %</td>
<td>3.5</td>
<td>3.8</td>
<td>5.8</td>
<td>6.0</td>
<td>5.4</td>
<td>4.0</td>
<td>4.1</td>
<td>6.1</td>
<td>7.9</td>
<td>8.2</td>
</tr>
<tr>
<td>Single-lumen PICCs placed, %</td>
<td>72.6</td>
<td>0</td>
<td>25.1</td>
<td>31.2</td>
<td>1.9</td>
<td>47.8</td>
<td>6.5</td>
<td>32.6</td>
<td>61</td>
<td>13.5</td>
</tr>
<tr>
<td>Mean (SD) dwell time, d</td>
<td>12.0 (12.9)</td>
<td>18.0 (15.4)</td>
<td>15.2 (14.1)</td>
<td>13.7 (12.7)</td>
<td>13.4 (11.8)</td>
<td>13.3 (12.4)</td>
<td>12.9 (11.8)</td>
<td>16.9 (13.7)</td>
<td>16.6 (16.3)</td>
<td>14.9 (13.7)</td>
</tr>
</tbody>
</table>

### Complication rates

- Mechanical complications, %
  - Site No.: 1 | 1 (1.4) | 6 (2.7) | 7 (3.6) | 8 (2.0) | 5 (1.4) | 8 (1.9) | 17 (4.3) | 30 (6.3) | 10 (2.5) | 1 (0.2) |
- Superficial thrombophlebitis, %
  - Site No.: 1 | 1 (1.4) | 1 (0.4) | 0 | 7 (1.7) | 0 | 6 (1.4) | 0 | 8 (1.7) | 1 (0.3) | 5 (1.2) |
- Catheter occlusion, %
  - Site No.: 1 | 1 (1.4) | 2 (0.6) | 7 (1.7) | 17 (8.7) | 3 (3.2) | 6 (1.7) | 91 (21.9) | 112 (27.9) | 30 (6.3) | 59 (14.9) |
- Exit-site infection, %
  - Site No.: 0 | 0 | 2 (0.6) | 1 (0.2) | 0 | 2.5 | 1 (0.2) | 0 | 7 (1.5) | 0 | 1.0 |
- VTE, DVT, and PE, %
  - Site No.: 0 | 0 | 5 (2.2) | 24 (6.6) | 27 (6.5) | 25 (6.2) | 17 (3.6) | 27 (6.8) | 26 (6.2) |
- CLABSI, %
  - Site No.: 0 | 0 | 2.0 | 1 (0.2) | 3 (6.6) | 1 (0.2) | 6.4 | 1 (0.2) | 10 (2.1) | 3 (0.8) | 3 (0.7) |
- PICCs with ≥1 complication, %
  - Site No.: 3 | 1 (0.4) | 34 (17.4) | 39 (9.5) | 47 (13.0) | 121 (29.1) | 144 (35.9) | 10 (2.1) | 12 (2.3) | 93 (23.4) | 42 (9.9) |

### Table. Hospital Characteristics, PICC Use, and Complications

#### Facility characteristics
- Total beds, No.
  - Site No.: 136 | 2920 | 3.1 | 3.23/3 | 3.0, 2.5 |
- Total discharges, No.
  - Site No.: 183 | 7154 | 4.6 | 2.74/2 | 2.7, 2.0 |
- Average length of stay, d
  - Site No.: 208 | 9886 | 3.5 | 4.05/4 | 4.0, 3.0 |
- Charlson-Deyo Score, mean/median
  - Site No.: 356 | 14,821 | 4.4 | 3.32/3 | 3.3, 2.7 |
- PICCs placed, No.
  - Site No.: 383 | 40,545 | 5.1 | 5.4 |
- PICC use rate, %
  - Site No.: 513 | 33,252 | 4.5 |
- Single-lumen PICCs placed, %
  - Site No.: 632 | 56,627 | 4.5 |
- Mean (SD) dwell time, d
  - Site No.: 6000 | 47,716 | 6.2 |

#### Complication rates

- Mechanical complications, %
  - Site No.: 993 | 3758 | 6.2 |
- Superficial thrombophlebitis, %
  - Site No.: 877 | 2857 | 6.2 |
- Catheter occlusion, %
  - Site No.: 838 | 2240 | 6.2 |
- Exit-site infection, %
  - Site No.: 1 | 0 |
- VTE, DVT, and PE, %
  - Site No.: 1 | 0 |
- CLABSI, %
  - Site No.: 1 | 0 |
- PICCs with ≥1 complication, %
  - Site No.: 1 | 0 |

### Abbreviations
- CLABSI, central line–associated bloodstream infection; DVT, deep vein thrombosis; PE, pulmonary embolism; PICC, peripherally inserted central catheter; VTE, venous thromboembolism.
of patient illness ($r = -0.43$) or by hospital-level factors, including volume, bed number, type (teaching vs non-teaching), or location (urban vs rural). In addition, indications for PICC placement varied significantly across hospitals. For example, placement of PICCs for difficult venous access ranged from 10% to 64% ($P < .001$). Similarly, the frequency of PICC complications also varied, from 4.1% to 35.9%, or 0.041 to 0.406 complication per PICC, across hospitals ($P < .001$). Notably, patterns of complications also differed across hospitals. For example, catheter thrombosis was the most prevalent complication at 6 hospitals, whereas venous thromboembolism was the most prevalent adverse event in 2 hospitals.

Discussion | This multicenter study found substantial variation in PICC indications, patterns of use, and outcomes at 10 Michigan hospitals. Because PICCs are associated with numerous complications, it is necessary to understand the factors responsible for variations in their use. Additionally, because up to 24.2% of PICCs were removed within 5 days of insertion, guidance to better inform physicians about when a PICC may be appropriate appears necessary. The recently developed Michigan Appropriateness Guide for Intravenous Catheters (MAGIC) guidelines$^{6}$ are well suited to this purpose. Created by an international, multidisciplinary panel of vascular access experts and a patient representative, development of the MAGIC guidelines used the RAND, University of California, Los Angeles appropriateness method$^{7}$ to define when PICC insertion is appropriate, inappropriate, or uncertain as compared with the use of other vascular access devices. Among several appropriateness ratings, key recommendations of MAGIC include avoidance of placing PICCs for delivery of peripherally compatible infusions when the expected duration of such use is 5 days or greater; avoidance of inserting PICCs in patients with active cancer for chemotherapy when such treatment is expected to last less than 3 months and can be delivered through peripheral veins; and avoidance of placing PICCs in patients with kidney disease of stage 3b or higher or in those receiving renal replacement therapy. In contrast, the MAGIC panelists rated PICC placement in hospitalized patients appropriate for indications such as the delivery of irritants or vesicants regardless of duration (eg, parenteral nutrition), invasive hemodynamic monitoring in critically ill patients who will require venous access for more than 15 days, and frequent phlebotomy when this is expected to last longer than 6 days.$^{8}$

To operationalize recommendations, MAGIC offers algorithmic decision trees tailored to clinical parameters, such as proposed duration of treatment, nature of infusate, and patient or device characteristics. Understanding how best to implement MAGIC guidelines across hospitals is thus an important next step that will both inform quality improvement efforts and improve the safety of venous access in hospitalized patients.

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Tanya Boldenow, MD
Scott Kaatz, DO, MSc
Steven J. Bernstein, MD, MPH
Scott A. Flanders, MD

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Drafting of the manuscript: Chopra, Smith.

Critical revision of the manuscript for important intellectual content: Chopra, Swaminathan, Boldenow, Kaatz, Bernstein, Flanders.

Statistical analysis: Chopra, Smith.

Obtained funding: Chopra, Flanders.

Administrative, technical, or material support: Chopra, Flanders.

Study supervision: Chopra, Bernstein, Flanders.

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Publication of Clinical Studies Supporting FDA Premarket Approval for High-Risk Cardiovascular Devices Between 2011 and 2013: A Cross-sectional Study

Selective publication of clinical studies supporting US Food and Drug Administration (FDA) approval of novel drugs and devices prevents patients and physicians from making informed decisions about these products. Among 149 novel therapeutics approved by the FDA between January 2005 and December 2011, a total of 326 of 380 (85.8%) supporting pivotal studies were published. In contrast, less than half of all studies supporting FDA Premarket Approval (PMA) of novel, high-risk cardiovascular devices between January 2000 and December 2010 were published, and more than one-fourth of these presented results in a manner discrepant with FDA reviews. It remains unknown whether contemporary practices of disseminating medical device research have improved in the wake of the 2007 FDA Amendment Act, which expanded the registration and reporting on clinicaltrials.gov to explicitly include medical devices. We therefore examined the publication and reporting of studies supporting novel, high-risk cardiovascular devices approved by the FDA between January 2011 and December 2013, which account for approximately half of all FDA PMAs, along with potential predictors of publication, including study, device, and company characteristics.

Methods | A search was done of the publicly accessible FDA PMA database (http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/pma.cfm) to identify all novel, high-risk cardiovascular devices approved between January 2011 and December 2013. Next, clinical studies supporting the approval were identified within the FDA documents and corresponding publications as of December 2015 and were searched for in a manner described previously, which included contacting the companies marketing these devices. A search was also made for all studies on clinicaltrials.gov. We categorized studies by type (pivotal or nonpivotal), device (FDA designated as implantable or nonimplantable, life-sustaining or non-life-sustaining, and priority or standard review), and company (public or private) characteristics. We compared the reporting of primary outcome results and study interpretation in publications and FDA reviews, categorizing publications as “concordant” if primary outcome results were an exact numerical match or differed by less than 5%. Analyses were performed using Microsoft Excel, version 14.1.0 (Microsoft Corporation).

Because our examination of trial publications did not involve human subjects, ethics committee review was not required by the Yale University Human Research Protection Program.

Results | Between January 2011 and December 2013, the FDA approved 35 novel, high-risk cardiovascular devices via the PMA pathway. We identified 70 supporting studies (mean, 2 per device), of which 56 were published in peer-reviewed literature (56 of 70 [80%]) (Table 1); 5 additional studies reported results on clinicaltrials.gov only. Pivotal studies (34 of 38 [89%]) were more likely to be published than nonpivotal studies (22 of 32 [69%]; P = .03). Studies of devices designated as life-sustaining (33 of 35 [94%]) were more likely to be published than devices designated as non-life-sustaining (23 of 35 [66%]; P = .004). Studies funded by public companies (47 of 54 [87%]) were more likely to be published than those funded by private companies (9 of 16 [56%]; P = .006). Among published studies, 3 primary outcome results were discordant, but only 1 discordance changed the interpretation of the study’s findings; the remaining published results were concordant with results reported within FDA reviews (Table 2).

Discussion | Among studies supporting FDA approval of novel, high-risk cardiovascular devices between January 2011 and December 2013, 8 of 10 reported their results in the peer-reviewed biomedical literature. Although this rate is consistent with the publication rate among pivotal trials supporting new drug approvals, it is substantially higher than the rate of 49% observed for trials supporting FDA-approved, high-risk cardiovascular devices between January 2000 and December 2010. Furthermore, nearly all publications in our study presented results in a manner concordant with FDA reviews, which was an improvement from prior study of medical device research results reporting.

Table 1. Publication of Trials Supporting FDA Premarket Approval for High-Risk Cardiovascular Devices From 2011 to 2013, Stratified by Study, Device, and Company Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Published, No. (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall (N = 70)</td>
<td>56 (80)</td>
<td></td>
</tr>
<tr>
<td>Supporting trial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pivotal (n = 38)</td>
<td>34 (89)</td>
<td>.03</td>
</tr>
<tr>
<td>Nonpivotal (n = 32)</td>
<td>22 (69)</td>
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<tr>
<td>Implantable designation</td>
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</tr>
<tr>
<td>Implantable (n = 58)</td>
<td>47 (81)</td>
<td>.63</td>
</tr>
<tr>
<td>Nonimplantable (n = 12)</td>
<td>9 (75)</td>
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<td>Life-sustaining designation</td>
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<td>Life-sustaining (n = 35)</td>
<td>33 (94)</td>
<td>.004</td>
</tr>
<tr>
<td>Non–life-sustaining (n = 35)</td>
<td>23 (66)</td>
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<tr>
<td>FDA review pathway</td>
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<tr>
<td>Priority review (n = 13)</td>
<td>10 (77)</td>
<td>.76</td>
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<tr>
<td>Standard review (n = 57)</td>
<td>46 (81)</td>
<td></td>
</tr>
<tr>
<td>Company management</td>
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</tr>
<tr>
<td>Public (n = 54)</td>
<td>47 (87)</td>
<td>.006</td>
</tr>
<tr>
<td>Private (n = 16)</td>
<td>9 (56)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: FDA, US Food and Drug Administration.

*Published includes publication in the peer-reviewed biomedical literature; does not include 5 additional studies that reported results on clinicaltrials.gov only.

†A trial was considered pivotal if it was the only trial included in the summary or if it was explicitly designated as pivotal; all other trials were nonpivotal.

‡FDA designation.