Registry Assessment of Peripheral Interventional
Devices (RAPID)
— Registry Assessment of Peripheral Interventional
Devices Core Data Elements —

W. Schuyler Jones, MD; Mitchell W. Krucoff, MD; Pablo Morales, MD;
Rebecca W. Wilgus, RN, MSN; Anne H. Heath, BA; Mary F. Williams, BS;
James E. Tcheng, MD; J. Danica Marinac-Dabic, MD, PhD; Misti L. Malone, PhD;
Terrie L. Reed, MS; Rie Fukaya, MMedSc; Robert Lookstein, MD; Nobuhiro Handa, MD;
Herbert D. Aronow, MD, MPH; Daniel J. Bertges, MD; Michael R. Jaff, DO;
Thomas T. Tsai, MD, MSc; Joshua A. Smale, BS; Margo J. Zaugg, BSN;
Robert J. Thatcher, MBA; Jack L. Cronenwett, MD; Durham, NC; Silver Spring, MD;
Tokyo, Japan; New York, NY; Providence, RI; Burlington, VT; Newton, Mass; Denver, Colo;
Tempe, Ariz; Santa Clara, Calif; Minneapolis, Minn; Lebanon, NH

Background: The current state of evaluating patients with peripheral artery disease and more specifically of evaluating medical
devices used for peripheral vascular intervention (PVI) remains challenging because of the heterogeneity of the disease process,
the multiple physician specialties that perform PVI, the multitude of devices available to treat peripheral artery disease, and the
lack of consensus about the best treatment approaches. Because PVI core data elements are not standardized across clinical
care, clinical trials, and registries, aggregation of data across different data sources and physician specialties is currently not feasible.

Methods and Results: Under the auspices of the U.S. Food and Drug Administration’s Medical Device Epidemiology Network
initiative—and its PASSION (Predictable and Sustainable Implementation of the National Registries) program, in conjunction with
other efforts to align clinical data standards—the Registry Assessment of Peripheral Interventional Devices (RAPID) workgroup was
convened. RAPID is a collaborative, multidisciplinary effort to develop a consensus lexicon and to promote interoperability across
clinical care, clinical trials, and national and international registries of PVI. The current manuscript presents the initial work from
RAPID to standardize clinical data elements and definitions, to establish a framework within electronic health records and health
information technology procedural reporting systems, and to implement an informatics-based approach to promote the conduct of
pragmatic clinical trials and registry efforts in PVI.

Conclusions: Ultimately, we hope this work will facilitate and improve device evaluation and surveillance for patients, clinicians,
health outcomes researchers, industry, policymakers, and regulators.

Key Words: Core data element; Medical device registry; Peripheral arterial disease
Peripheral artery disease (PAD) has a high morbidity and mortality, and the prevalence and costs associated with the diagnosis and management of PAD continually increase.\(^1\)\(^-\)\(^3\) Despite the increasing burden on the health care system, relatively few comparative effectiveness studies are being performed of patients with PAD in the United States.\(^4\) Multiple efforts by professional societies, academia, industry partners, and the U.S. Food and Drug Administration (FDA) have recently been undertaken to better define the nomenclature and classification of how patients with PAD are evaluated and treated in clinical practice.\(^5\)\(^-\)\(^8\) Despite these efforts, the current state of evaluating patients with PAD and more specifically of evaluating medical devices used for peripheral vascular intervention (PVI) remain challenging because of the heterogeneity of the disease process (eg, symptom classification, anatomic location of disease, severity of disease), the multiple physician specialties that care for these patients and perform PVI, the multitude of devices available to treat PAD globally, the lack of consensus about best treatment approaches, and the absence of a consensus regarding a PAD-PVI lexicon. Furthermore, the medical device technologies for treating PAD have evolved at a face pace with relatively little comparative effectiveness or safety data to assess device performance and patient outcomes or to inform clinical guidelines. Finally, in real-world practice, many approved or cleared devices are used “off-label” in anatomic locations or clinical conditions that have not been rigorously studied.

As PVI core data elements are not standardized across clinical care, clinical trials, or registries, aggregation of data across different data sources and physician specialties is currently not feasible. Under the auspices of the FDA Medical Device Epidemiology Network (MDEpiNet) initiative and its PASSION (Predictable and Sustainable Implementation of the National Registries) program in conjunction with other efforts to align clinical data standards,\(^8\) the Registry Assessment of Peripheral Interventional Devices (RAPID) workgroup was convened to develop a consensus lexicon to promote interoperability across clinical care, clinical trials, and national and international registries of PVI.

**Goals of RAPID**

In 2010, the FDA launched the MDEpiNet initiative with the goal of advancing national and international infrastructure, novel methodologies, and partnerships for evaluation of medical devices throughout the product’s life cycle. In 2014, MDEpiNet matured to a public-private partnership that contributed to the construction and demonstration of a National Evaluation System for Health Technology. Key components being addressed by MDEpiNet include the need for integrated infrastructure for real-world data, the development of analytic methodologies, and the conduct of demonstration studies that generate high-quality data at lower overall cost than in current approaches that support regulatory and best practice decisions throughout the total device product life cycle.\(^9\)\(^-\)\(^11\)

The RAPID project was conceived by MDEpiNet to address the nomenclature and infrastructure gaps of the PVI space. The goals of RAPID are shown in the Fig and include the following:

- **Phase 1.** Standardization of core PVI concepts and development of the concepts into common data elements to allow utilization of data from multiple sources
**Table. Registry Assessment of Peripheral Interventional Devices (RAPID) Clinical Use Cases**

<table>
<thead>
<tr>
<th>Clinical use case characteristics</th>
<th>Premarket approval</th>
<th>Postmarket approval or surveillance</th>
<th>Randomized controlled trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project summary</td>
<td>Registry-embedded trial or pragmatic clinical trial</td>
<td>Longitudinal study embedded within registry or EHR system</td>
<td>Registry-embedded trial or pragmatic clinical trial</td>
</tr>
<tr>
<td>Goal</td>
<td>Comparative effectiveness and safety assessment of new device technology</td>
<td>Longitudinal effectiveness and safety assessment of approved device in clinical practice</td>
<td>Comparative effectiveness and safety assessment of pharmacologic therapy after PVI</td>
</tr>
<tr>
<td>Comparators</td>
<td>Device X (new technology) vs device Y (currently approved technology) or objective performance criteria</td>
<td>None; all patients receive treatment with an approved device (device Z)</td>
<td>1 month vs 6 months of dual antiplatelet therapy (aspirin+P2Y12 inhibitor)</td>
</tr>
<tr>
<td>Study design</td>
<td>Single-blind, 1:1 randomized controlled trial</td>
<td>Single-arm, nonrandomized study</td>
<td>Double-blind, 1:1 randomized controlled trial</td>
</tr>
<tr>
<td>Study population</td>
<td>All symptomatic patients with PAD undergoing PVI for intermittent claudication and critical limb ischemia; patients must have disease suitable for use of device X and device Y</td>
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</tr>
<tr>
<td>Enrollment</td>
<td>Example: All symptomatic patients undergoing planned infrainguinal endovascular revascularization</td>
<td>Example: All symptomatic PAD patients who have undergone successful PVI with device Z</td>
<td>Example: All symptomatic PAD patients who have undergone successful PVI</td>
</tr>
<tr>
<td>Follow-up</td>
<td>1 month, 3 months, 6 months, 12 months</td>
<td>1 month, 3 months, 6 months, 12 months</td>
<td>1 month, 3 months, 6 months, 12 months</td>
</tr>
<tr>
<td>Clinical outcomes</td>
<td>Acute, intermediate, and long-term cardiovascular end points; limb end points; functional measures; and quality of life measures</td>
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</tr>
</tbody>
</table>

EHR, electronic health record; PAD, peripheral artery disease; PVI, peripheral vascular intervention.

in both premarket and postmarket assessments of PAD interventional devices.

- Phase 2. Incorporation of the standardized data elements into two major existing registries, the Society for Vascular Surgery Vascular Quality Initiative (SVS VQI) and the American College of Cardiology National Cardiovascular Disease Registry Peripheral Vascular Intervention (ACC NCDR PVI), as well as into the procedure documentation systems of at least one health information technology (HIT) vendor.

- Phase 3. Establishment of a device evaluation project (eg, randomized clinical trial, device surveillance registry) using these data sources to demonstrate the benefit of interoperable device data collection for academia, clinicians, industry, payers, U.S. Centers for Medicare and Medicaid Services, FDA, and other global regulatory agencies.

With these considerations in mind, RAPID is aligned with the current FDA Center for Devices and Radiological Health initiative to improve the total product life cycle assessment of medical devices and to enhance the use of real-world data for regulatory decisions.9,10

**RAPID Collaborators**

RAPID was developed by forming a multi-stakeholder collaboration of academic members from various specialties that perform PVI, professional societies and their registries, U.S. federal agencies, international partners, HIT vendors, clinical research organizations, and medical device manufacturers. These collaborators are listed in Table S1. Outreach continues to expand the list of active participants who will add value to the RAPID project.

**Operational Aspects of RAPID**

The initial in-person meeting that formalized RAPID occurred on June 5, 2015, at the FDA White Oak Campus (Figure). The Duke Clinical Research Institute, which serves as the MDEpiNet Coordinating Center, was selected to provide administrative and informatics support for RAPID. Three workgroups were organized: a clinical group charged with identifying the core clinical concepts; an informatics group responsible for developing the clinical concepts into data elements; and a Global Unique Device Identifier Database (GUDID) workgroup to facilitate the use of device data in the FDA GUDID reference database. At this initial meeting, industry partners committed to financial support of RAPID through unrestricted research grants that were held at the Duke Clinical Research Institute.

Weekly teleconferences and a face-to-face meeting during the MDEpiNet annual meeting (October 1, 2015, Silver Springs, Maryland) were used to ensure participation by stakeholders and to organize the various working groups and their lead participants. On November 6, 2015, all RAPID stakeholders met at the American College of Cardiology Heart House in Washington, D.C., for a kickoff meeting to assign tasks and to introduce the clinical and informatics working group approaches that had begun at the Duke Clinical Research Institute. Following the kickoff meeting, the three working groups convened teleconferences every 1 to 2 weeks, and a near-final product for phase 1 was delivered to the entire group for review in Silver Springs, Maryland, on April 13, 2016. The content was then further edited and improved, with release of the artifacts to the general public occurring on September 14, 2016, on www.mdepinet.org.
Clinical Use Cases
To guide the clinical, informatics, and GUDID working groups, three potential clinical use cases were articulated as reference points and boundaries for the scope of the work. These included a premarket approval use case, a postmarket approval use case, and a randomized clinical trial use case. These use cases exemplify, at a high level, clinical care and regulatory contexts in which the core data elements could be successfully leveraged but do not represent an existing registry or project under development. Whereas many aspects of the clinical use cases were hypothetical (rather than factual), this exercise allowed working group members to think broadly about the PAD population being studied. Details about these use cases are in Table.

Core Data Element Selection
The Duke Clinical Research Institute informatics group evaluated, aggregated, and anonymized data elements from three U.S. professional society registry data forms, three international registry data forms (Germany, Japan, Australia), and seven device company case report forms. A total of 3904 data elements were abstracted, and 2021 of these were deemed specific to PAD; the remaining data elements were deemed to be not specific to PAD. These 2021 PAD-specific data elements were then shared with the clinical working group to derive the core data elements for RAPID. The remaining general data elements, such as the patient’s age, sex, and medical comorbidities and other general concepts, were not included because these elements will be collected as discrete data by electronic health record (EHR) and other clinical documentation systems and have also been defined and specified in many nationally used data models.\textsuperscript{12,13}

Domains and Clinical Concepts
The 2021 PAD-specific data elements were grouped into five domains: condition, test, procedure, device, and event/outcome. Through a series of interactive web conferences and face-to-face meetings during several months, a multi-stakeholder clinical working group reached consensus on the selection of exactly 100 key data elements (shown in Table S2), prioritized on the basis of their availability in existing data sources, applicability to most PVI devices, and applicability for use across the total product life cycle of PVI interventional devices (eg, early-phase clinical trials, pivotal clinical trials, device surveillance studies). These data elements can be applied at multiple time points during data collection for a clinical trial or registry (eg, at baseline, during the index PVI, during follow-up), and although it is expected that a large proportion of the data extraction will be accomplished using these core data elements, specific clinical trials and device evaluation studies may need to collect an additional set of variables, depending on how a specific device functions.

Informatics Workflow
After the selection of this minimal set of core data elements, the informatics working group convened to develop the metadata (ie, data that serve to provide context or definition about other data) sufficient for the clinical concepts to be implemented as data elements in electronic HIT systems.

The informatics working group followed a permissive approach to be as compatible as possible with the data models currently in use today (including Observational Medical Outcomes Partnership [OMOP], Sentinel, Patient-Centered Outcomes Research Network [PCORnet], Informatics for Integrating Biology & the Bedside [i2b2], Open Clinical Information Modeling Initiative [OpenCIMI], and others) and to support workflows such as the following:
- Federated and distributed research networks (eg, Sentinel, PCORnet)\textsuperscript{12,14}
- Electronic data capture systems (clinical trial-specific databases)
- Multisource, multidata type research (or device evaluation) repositories
- Point-of-care clinical, procedural, and EHR systems with downstream flows to quality improvement registries and other systems used for outcomes analysis
- Data collection systems not set up to receive or to exchange data with EHR systems

In other words, the identification of the core clinical lexicon anticipates clinical care processes that capture data integrated into clinical workflows and the interoperable use of the corresponding data element representations by clinical registries and in the aggregation of rich data sets for analytic purposes. Future work is under way to determine how to procure the data elements from a specific EHR system or electronic data capture system. As this process is developed and tested, it will be imperative to validate the veracity and security of the data extraction process. Ultimately, demonstration projects will be performed that test the value of using the RAPID common data elements for PAD-specific projects, and much of the future workflow (eg, where the data are stored, access to data) will be determined by the specific project (eg, randomized controlled trial, clinical registry, safety surveillance project).

GUDID Workflow
Another novel unmet medical need addressed in this RAPID program is that electronic HITs do not currently have a consistent, efficient mechanism to capture and to link device identification information to the patient at the point of care or across data sources. In 2013, the FDA established a unique device identifier (UDI) system to adequately identify medical devices through their distribution and use. UDI requirements are being phased in over several years on the basis of the risk of the device. When the system is fully implemented, the label of most devices will include a UDI in both human- and machine-readable forms. Device labelers must also submit certain information about each device to the FDA’s GUDID. At the time of writing, mechanisms to integrate UDI into workflows or to associate implantable device UDI with patients over time and across venues are not widely available. In the future, the ability to link device UDI with the patient will facilitate data entry into registries such as the ACC NCDR PVI and SVS VQI that began recording device information in 2016.

The RAPID GUDID working group was formed to explore and understand opportunities for incorporating UDI and the FDA GUDID reference database into the core clinical data for RAPID. The GUDID integration working group sought to promote knowledge sharing across the FDA, device manufacturers, clinicians, and registries related to using the device identifier of the UDI.
to extract data from GUDID and to facilitate the transition from existing nonstandardized device identification in device registries to one based on the device identifier portion of the UDI.

The evaluation of GUDID data spawned the creation of additional initiatives. These address augmenting the GUDID system with additional clinically useful device attributes; understanding and improving device categorization; and improving the quality of data in GUDID by decreasing discrepancies, inconsistencies, and errors in the entries into the GUDID system for clinically relevant values, such as size and diameter of the device. Additional workgroups formed under the auspices of MDEpiNet and the Association for Healthcare and Resource Management Learning UDI community will provide the mechanisms to delineate and to suggest approaches to resolving these issues.

**Data Elements and Definitions**

The RAPID clinical data elements are listed in Table S2, and a few points warrant highlighting. In addition to deriving core data elements from existing sources, the clinical workgroup provided additional specificity and definition for several key variables. A modified Rutherford classification for PAD symptoms was developed to increase specificity regarding delineation of the activity limitations for patients with mild, moderate, and severe claudication. Whereas many registries and prior studies described patients with critical limb ischemia using a Rutherford classification, the clinical working group recommended use of the now validated Wound, Ischemia, and Foot Infection classification system for grading the severity of critical limb ischemia in the RAPID core data elements.7 Definitions for lesion length, degree of lesion stenosis, and degree of vascular calcification were actively debated among stakeholders, as these data elements have been inconsistently documented across typical data sources. A consensus was reached as to how best to classify these in RAPID.

A decision was made to include each target lesion treated during a procedure, to assign a lesion number, and to track the outcome of this target lesion longitudinally. In addition, it was decided to include each access site location, sheath size, and guidance used for access (eg, palpation only, fluoroscopy, ultrasound, open exposure). The included events and outcomes pertain to periprocedural events and the management of these events; however, more generic end points, such as myocardial infarction, stroke, and death, were not included in the RAPID core data elements that focus on PVI-specific outcomes. These events may require identification and longitudinal tracking outside of the EHR and HIT procedural reporting systems (eg, administrative claims data, National Death Index).

Medications of interest that were included in the RAPID core data elements include the following:

- Antithrombotic medications (eg, aspirin, P2Y12 receptor inhibitors, unfractionated heparin, low-molecular-weight heparin, glycoprotein IIb/IIIa inhibitors, bivalirudin, oral anticoagulants)
- Other cardioprotective medications (eg, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, hydroxymethylglutaryl-coenzyme A reductase inhibitors [statins])
- Cilostazol, pentoxifylline

**RAPID Phase 2**

The second phase of RAPID involves the dissemination and implementation of the RAPID core data elements. The priorities of phase 2 include

- Identification of non-PVI-specific data elements from other data models
- Introduction of the RAPID clinical data elements into the OpenCIMI data modeling process (ie, develop the formal informatics of the RAPID clinical data elements)
- Implementation of the RAPID clinical data elements in HIT procedural documentation systems (eg, the Veterans Affairs system procedure documentation module, Clinical Assessment, Reporting, and Tracking System for Cardiac Catheterization Laboratories)
- Implementation of the RAPID clinical data elements in three different U.S. professional society registries
  - ACC NCDR PVI
  - Society of Interventional Radiology National Interventional Radiology Quality Registry
  - SVS VQI
- Development of an augmented UDI data set of clinical data for all classes of PAD interventional devices
- Dissemination of RAPID clinical data elements along with prototype history and physical examination data, structured reports, and structured reporting approaches for PVI (to all HIT procedure documentation systems)
- Continued work on an augmented unique device identification database
- Recommendations for structured reporting systems and documents

**RAPID Phase 3**

The third phase of RAPID will be able to demonstrate a significantly improved approach to PVI device research in the United States and internationally. For example, RAPID will be able to facilitate the International Consortium of Vascular Registries effort to harmonize the SVS VQI and European Vascunet registries. The SVS VQI and ACC NCDR PVI steering committees have already approved the addition and consolidation of RAPID data elements into their individual workflow. Although differences exist in how data are entered into each registry (ie, real-time data entry at the point of care vs data abstraction after a care episode), the standardization and use of core data elements, informatics workflow, and GUDID implementation from RAPID make the possibilities almost limitless. However, as in all projects, the approach to phase 3 requires intense focus and strategic planning. Concepts from the use cases (Table) or alternative research proposals will be used to design a study or studies to be performed, but it will be imperative for government, industry, or other funding agencies to operationalize the data elements and data collection approach. Similar pragmatic trials or surveillance programs, such as studies using the RAPID core data elements and infrastructure, will have the potential to be more efficient, more comprehensive, and less costly than traditional methods of data collection.15 Society registries have demonstrated the feasibility of such standardized approaches (eg, American College of Cardiology National Cardiovascular Data Registry Transcatheter Valve Therapy registry), but the RAPID approach will be the first comprehensive effort in the complex PAD space.
Conclusions

RAPID is a demonstration project for the MDEpiNet public-private partnership, and as such, it is designed to improve device evaluation and surveillance for patients, clinicians, researchers, industry, policymakers, and regulators. Similarly, RAPID is one project in a series initiated to advance and to demonstrate the interoperable flow of data and information across electronic health information systems as a precursor to the National Evaluation System for Health Technology articulated by Shuren and Califf.9 RAPID will serve as a collaborative, multidisciplinary model for the standardization of clinical data elements and definitions, establishment of a framework within EHR and HIT procedural reporting systems, and implementation of an informatics-based approach to promote the conduct of pragmatic clinical trials nested in the national and international registries of PVI. In doing so, RAPID has laid the groundwork to promote more efficient data collection and more streamlined clinical trial processes. As a demonstration project under the MDEpiNet's PASSION program, RAPID is designed to maximize the efficiencies of clinical trials nested in the registries. These efforts have just begun, and it will require continued focus and collaboration to complete the second and third phases of work.

Registry Assessment of Peripheral Interventional Devices (RAPID) working group members included representatives from academic research groups from the United States, Japan, and Europe; representatives from vascular medicine, vascular surgery, interventional radiology, and cardiology; industry representatives; the U.S. Food and Drug Administration; and the Pharmaceuticals and Medical Devices Agency regulatory authorities from Japan.

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Overall Responsibility: W.J.

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Author Conflict of Interest
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Disclosures
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Supplementary Files

Supplementary File 1

Table S1. Registry Assessment of Peripheral Interventional Devices (RAPID) collaborators

Table S2. Registry Assessment of Peripheral Interventional Devices (RAPID) data elements

Please find supplementary file(s): http://dx.doi.org/10.1253/circj.CJ-17-1156