The National Evaluation System for health Technology (NEST): Priorities for Effective Early Implementation

for Effective Early Implementation

A NEST Planning Board Report

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About the Duke-Margolis Center for Health Policy

The Duke-Robert J. Margolis, MD, Center for Health Policy, founded with a gift from Duke University School of Medicine alumnus Robert J. Margolis and his wife Lisa, connects the intellectual resources at Duke with policymakers and policy analysts in the public and private sector. Disciplines involved in the Duke-Robert J. Margolis, MD, Center for Health Policy will include business, biomedical research, clinical care, public policy, global health, law and other areas.

The Duke-Margolis Center has staff and offices in both Durham and at Duke's center in Washington, D.C. It has participation from faculty and staff at Fuqua, Sanford School of Public Policy, School of Medicine, School of Law and other units, and collaborates with experts and health care reformers from across the country and around the world. The center's activities include serving as a hub for translational policy research and analysis - that is, for supporting the movement of promising ideas in health reform into the implementation of effective policy.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This is the third in a series of reports from the Planning Board to support the U.S. Food and Drug Administration's (FDA) work to establish the National Evaluation System for health Technology (NEST). NEST is envisioned as a cooperative network of partners working to use data, advanced methodologies, and good governance to improve the state of medical device evidence generation.

This report outlines recommendations on organizational governance such as operational leadership, bylaws, and the creation of a representative governing board for a Coordinating Center (Coordinating Center) charged with building NEST. The Planning Board has also included priority areas and activities for the strategic development of the Coordinating Center including data governance and recommendations for high-value demonstration project areas.

The Planning Board previously proposed that a Coordinating Center be established to develop NEST's shared resources which should include: 1) building a voluntary network of data partners with re-usable data use and sharing agreements; 2) fostering a network of methodological expertise and a clearinghouse of best practices; and 3) establishing an effective multi-directional communication platform for stakeholders and the broader public.[1]

The Planning Board recommends the Coordinating Center use demonstration projects as a way to develop these shared resources while also showing the value of a nationally coordinated approach to bridging efforts and closing the gaps in medical device evaluation. The Planning Board recommended that these projects take place in two phases with aggressive timelines for initiation and completion; phase one projects should be feasibly completed within three years, and phase two projects should be completed within five years.

The recommended goals of phase one demonstration projects include:
- Effective and efficient balancing of pre- and postmarket device evidence development; and
- Building towards an active surveillance system by improving safety surveillance of medical devices.

The recommended goals of phase two demonstration projects include:
- Enhancing data collection and integrating health information technology (health IT) systems for improved evaluations of Class 2 devices;
- Promoting methods for patient-mediated data sharing; and
- Developing approaches and capabilities within the NEST infrastructure for measuring device value.

These projects should be used to show the value of the Coordinating Center, build the shared resources of NEST, as well as be an opportunity to test and refine the Center's foundational priorities, process designs, and governance policies.

ACRONYNS AND ABBREVIATIONS

ACO	Accountable care organization
AHRQ	Agency for Healthcare Research and Quality
AIDC	Automatic identification and data capture technology
API	Application programming interface
ASTER-D	Adverse Event Triggered Event Reporting for Devices
BUILD	Building UDI into Longitudinal Data for Medical Device Evaluation Initiative
CathPCI	Cardiac catheterization and percutaneous coronary intervention
CDC	U.S. Centers for Disease Control and Prevention
CDRH	Center for Devices and Radiological Health
CMS	Centers for Medicare & Medicaid Services
CRN	Coordinated registry networks
DELTA	Data Extraction and Longitudinal Trend Analysis System
DUA	Data use agreements
EHI	Electronic health information
EHR	Electronic healthcare record
FDA	U.S. Food and Drug Administration
FHIR	Fast Healthcare Interoperability Resources
GUDID	Global Unique Device Identification database
HHS	U.S. Department of Health and Human Services
HIPAA	Health Insurance Portability and Accountability Act of 1996
health IT	Health information technology
HL7	Health Level Seven International
IDE	Investigational device exemption
IRB	Institutional Review Board
MDEpiNet	Medical Device Epidemiological Network
MDIC	Medical Device Innovation Consortium
MDISS	Medical Device Innovation, Safety and Security Consortium
MDR	Medical device reporting
mHealth	Mobile health: a term used for medicine supported by mobile devices
NCDR	National Cardiovascular Data Registry
NEST	National Evaluation System for health Technology
NIH	National Institutes of Health
OHRP	Office of Human Research Protections
ONC	Office of the National Coordinator for Health Information Technology
PCORI	Patient-Centered Outcomes Research Institute
PCORnet	National Patient-Centered Clinical Research Network
PHI	Personal health information
PMA	Pre-market approval
PMI	Precision Medicine Initiative
RAPID	Registry Assessment of Peripheral Interventional Devices
SAFE-STEMI	Study of Access site For Enhancing PCI in STEMI for Seniors
TVT	Transcatheter Valve Therapy
UDI	Unique Device Identifiers

PROJECT HISTORY

In 2014, the FDA and the Center for Health Policy at the Brookings Institution[*] convened a Planning Board for a national medical device evaluation system. The Planning Board is a multi-stakeholder group with representation from patients, clinicians, hospitals, researchers, health plans, industry, and experts in health information systems, as well as key government agencies, including FDA, the National Institutes of Health (NIH), the Agency for Healthcare Research and Quality (AHRQ), the Centers for Medicare & Medicaid Services (CMS), and the Office of the National Coordinator for Health Information Technology (ONC). The Planning Board was tasked with creating a long-term vision of a sustainable national system to evaluate the risks and benefits of medical devices – NEST. The Planning Board released its first report *Strengthening Patient Care: Building an Effective National Medical Device Surveillance System*, in February 2015.[2] In that report, the Planning Board described a public-private partnership tasked with driving the development of a national system that meets the needs of stakeholders that use, produce, evaluate, pay for, and regulate medical devices, specifically patients, clinicians, hospitals, industry, insurers, researchers, and government agencies.

The Planning Board recommended that the mission of NEST be to **support optimal patient care through the use of real-world evidence on medical devices to promote the public health**. NEST should fulfill this important mission by cooperatively facilitating use of developing electronic health information infrastructure[†] to support affordable, timely, and reliable evidence generation. This evidence should be used for active safety surveillance and more effective regulatory decision-making by FDA, as well as to foster innovation by partnering with stakeholders to support their high-priority evidence needs that could benefit from the same infrastructure.

In September 2015, the National Medical Device Registry Task Force released their report on *Recommendations for a National Medical Device Evaluation System: Strategically Coordinated Registry Networks to Bridge Clinical Care and Research*.[3] FDA asked the Robert J. Margolis, MD, Center for Health Policy at Duke University[*] to reconvene the Planning Board to help lead the next phase of the system's coordinating center and governing body development. This work was designed to support FDA's Center for Devices and Radiological Health (CDRH) 2016-2017 Strategic Priorities to establish NEST and increase access to and use of real-world evidence to support regulatory decision making and technological innovation.[4]

The Planning Board was given the following tasks:
- Identify the objectives and tasks for a Coordinating Center to operationalize the mission, governing principles, and proposed functions needed to build NEST;
- Recommend strategic and governance priorities for the implementation of the Coordinating Center and the development of NEST; and
- Propose early activities and projects that implement components of NEST, pilot organizational and data governance, and engage key stakeholders to ensure the sustainability of the Coordinating Center.

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[*]At the time of convening, the FDA cooperative agreement was held by the Center for Health Policy at the Brookings Institution. In January 2016, the cooperative agreement was transferred to the Duke-Robert J. Margolis, MD, Center for Health Policy.

[†]This electronic health information infrastructure includes such entities as Sentinel, PCORnet, registries, all-payer databases, health IT systems used for clinical care or payment, clinical research data, emerging databases with patient-reported outcomes, etc. While not yet interoperable, many systems are making great strides in this direction, with the help of ONC and others. The NEST Coordinating Center will need to be a partner and a resource in this effort.

In April 2016, the Planning Board released their second report "*Better Evidence on Medical Devices: A Coordinating Center for a 21st Century National Medical Device Evaluation System,*" which proposed capabilities, objectives, and tasks for a NEST Coordinating Center. The Planning Board recommended that the Coordinating Center be responsible for developing the shared resources that would be the foundation of NEST:

- A voluntary network of data partners;
- A clearinghouse of best practices in medical device evidence development; and
- Methods to effectively disseminate actionable information on medical device safety and effectiveness to patients and across the medical device ecosystem to support FDA's mission.[5]

This report builds on the Planning Board's previous work to outline recommendations on the organizational structure for a new Coordinating Center, priorities for initial structural governance, and potential high priority and system-enabling projects that would demonstrate the value of a coordinated national system approach to integrating medical device evaluations into the wider learning healthcare system.[6]

UNDERSTANDING STAKEHOLDER NEEDS AND PERSPECTIVES

Over the course of the past year, the Planning Board conducted targeted activities to assess the potential gaps in current evidence development activities related to medical devices and identify how a Coordinating Center could fill those gaps. The Planning Board and staff formed a small technical working group which gathered information about current medical device studies funded through FDA. Additionally, the Planning Board and staff used expert interviews and informal questionnaires to facilitate the collection of input from patients, the medical device industry, and health systems professionals about: 1) the challenges and burdens in conducting medical device evidence generation activities; and 2) what functions could the Coordinating Center facilitate to address those challenges. These web-based questionnaires were sent to a selected group of representatives. While this information provides some preliminary input, the Planning Board recommends that the Coordinating Center build on this work to develop a more thorough and ongoing needs assessment as outlined in the April 2016 report.

PATIENT VIEWPOINTS

Patient respondents were enthusiastic about having a mechanism to communicate with the FDA and industry, as well as a way to reliably be alerted to safety issues regarding their medical devices. These respondents also expressed interest in working with the FDA and industry to incorporate patient perspectives into experimental designs, including identifying acceptable benefit-risk profiles of new medical devices. Patients thought faster and more accurate information regarding medical device safety alerts and recalls was extremely important to their health, and most were willing to share their health information with the FDA and device manufacturers to study potential safety problems.

MEDICAL DEVICE INDUSTRY VIEWPOINTS

Given the diversity of the medical device industry, interviews and questionnaires were grouped into three categories: start-ups/venture capital firms, small to mid-sized manufacturers (generally less than 5,000 employees), and large manufacturers (more than 5,000 employees). When asked about the challenges of evidence development, a common theme was the high burden related to patient recruitment and engagement. Stakeholders representing start-ups and venture capital firms reported devoting a high amount of attention and resources to studies for indication expansion, labeling, and marketing. Representatives from small

manufacturing firms expressed difficulty in managing and monitoring clinical trials sites for successful and timely trial completion. They also reported high levels of resources devoted to managing international approvals and confirmatory studies for market expansion. Representatives from large manufacturers indicated that safety surveillance reporting and the management of Medical Device Reporting (MDR) demand a relatively high amount of resources. Start-up/venture capital-backed manufacturing representatives saw value in a Coordinating Center that would promote methods to reduce the burden of MDR reporting. They also expressed interest in standardizing methodologies for producing data for coverage decisions and medical professional society recommendations. Large manufacturing representatives reported that promoting data standardization and automation to reduce the burden and cost of data extraction from health IT could be an important function of the Coordinating Center. In addition, they saw value in the Coordinating Center connecting manufacturers with expertise and resources for research and evidentiary needs.

HEALTH SYSTEM VIEWPOINTS

Healthcare providers, including supply chain professionals, working across a broad array of organizations provided a unique perspective on their diverse needs for medical device information. Clinician researchers reported challenges to tracking patients longitudinally for better assessments of medical device exposures and a more complete health record. Some of the supply chain professionals contacted said that they are already capturing UDI electronically, mostly through an enterprise resource planning (ERP) solutions or the electronic healthcare record (EHR). They felt that there is a lack of impartial studies, particularly regarding comparative effectiveness in medical devices. They reported experiencing substantial burden in collecting and analyzing medical device information for value analyses. This group generally identified cardiovascular devices, orthopedic devices, and surgical devices as high-priority therapeutic device areas where additional information is needed. Clinicians also saw value in building systems for routine real-world data capture. They saw value in a Coordinating Center that could support faster, more cost-effective comparative effectiveness studies, including providing efficient pathways to access real-world evidence, and developing and promoting standardized therapeutic outcome measures.

PAYER VIEWPOINTS

Representatives from payer organizations indicated their interest in covering and reimbursing medical devices that bring value to members and beneficiaries alike for more efficient care. They see value in building networked health IT systems for routine real-world data capture to generate the evidence needed for coverage and reimbursement decisions. These representatives were interested in using medical device and combined claims data to track patient outcomes longitudinally. There was particular interest in being able to efficiently evaluate devices that generally do not have registries. Payer representatives saw the highest value in a Coordinating Center that could support faster, more cost-effective comparative effectiveness studies, including providing efficient pathways to access real-world evidence, and developing and promoting standardized therapeutic outcome measures. Payer representatives indicated that they often cannot conduct such studies on their own, and even large payers lack the clinical data that could be available through a combined data approach. For example, payers often ask for comparative effectiveness studies or information, not just between devices, but between different therapeutic options which may include variability in the setting of care, type of medical specialist, and interventions. The Coordinating Center's work on the shared resources could contribute to efforts to improve data on the effectiveness of devices, which will help to enable broader economic and health outcomes studies.

COORDINATING CENTER ORGANIZATIONAL GOVERNANCE

This section expands on the Planning Board's past reports, and provides insights on process steps needed to establish the Coordinating Center as a successful and ultimately independent public private partnership. The Coordinating Center organizational governance and operational structure should be guided by NEST's mission statement and the principles established in the February 2015 Planning Board Report (Appendices A, B, and C). These principles are meant to ensure that NEST and its Coordinating Center are free from bias and guided by FDA priorities, patient- and clinician-focused, collaborative, adaptable to "the learning health care system," trustworthy, transparent, secure, and focused on creating efficiencies by maximizing utility and minimizing burden.

As laid out in the April report, the initial steps in establishing the Coordinating Center's organizational governance are the selection of a founding executive director, the creation of the founding organizational bylaws, and the establishment of the Governing Board. The relationship and roles of various components of the Coordinating Center organization are illustrated in Figure 1.

OPERATIONAL LEADERSHIP

The Planning Board recommends selecting an interim executive director to provide initial operational leadership and oversee the Coordinating Center staff. The interim executive director will be responsible for working with the broader group of stakeholders to lead the development of the founding organizational bylaws and the selection process for the Governing Board.

FOUNDING BYLAWS

In each of the past reports, the Planning Board has stressed the importance of transparent and representative governance structure and policies for the Coordinating Center to maintain the trust and confidence of stakeholders. The founding bylaws will be the first step in establishing the governance foundation of the Coordinating Center and its partnerships that will build on that trust.

The Coordinating Center will require many partners in order to achieve its goal of building NEST's shared resources. Each partner will have internal policies which will influence their ability to participate in the network, including their organizational legal structure and business model. International organizations wishing to participate in the Coordinating Center may have other restrictions and requirements. The Coordinating Center will need to be cognizant of these challenges in developing bylaws that foster partnerships and collaboration.

GUIDING PRINCIPLES FOR THE COORDINATING CENTER

- Patient- and clinician-focused
- Optimize public health
- Clear and transparent
- National learning healthcare system integration
- Forward-looking and adaptive
- Maximizing utility and minimizing burden
- Standards-driven
- Interoperability-driven
- Sustainability-driven
- Responsive to privacy and security concerns

FIGURE 1: DEPICTION OF THE NATIONAL EVALUATION SYSTEM FOR HEALTH TECHNOLOGY (NEST) AND ITS COORDINATING CENTER. NEST is proposed to be a network of voluntary partners interacting with the three NEST shared resources. These shared resources will be developed and maintained by the NEST Coordinating Center for improved medical device evidence generation and evaluation. The Governing Board will be responsible for internal policy development, strategic planning and overall oversight of the Coordinating Center. The Executive Director will interface with the Governing board and oversee day-to-day operations, while the staff will be responsible for the programmatic implementation necessary to develop and maintain the NEST shared resources.
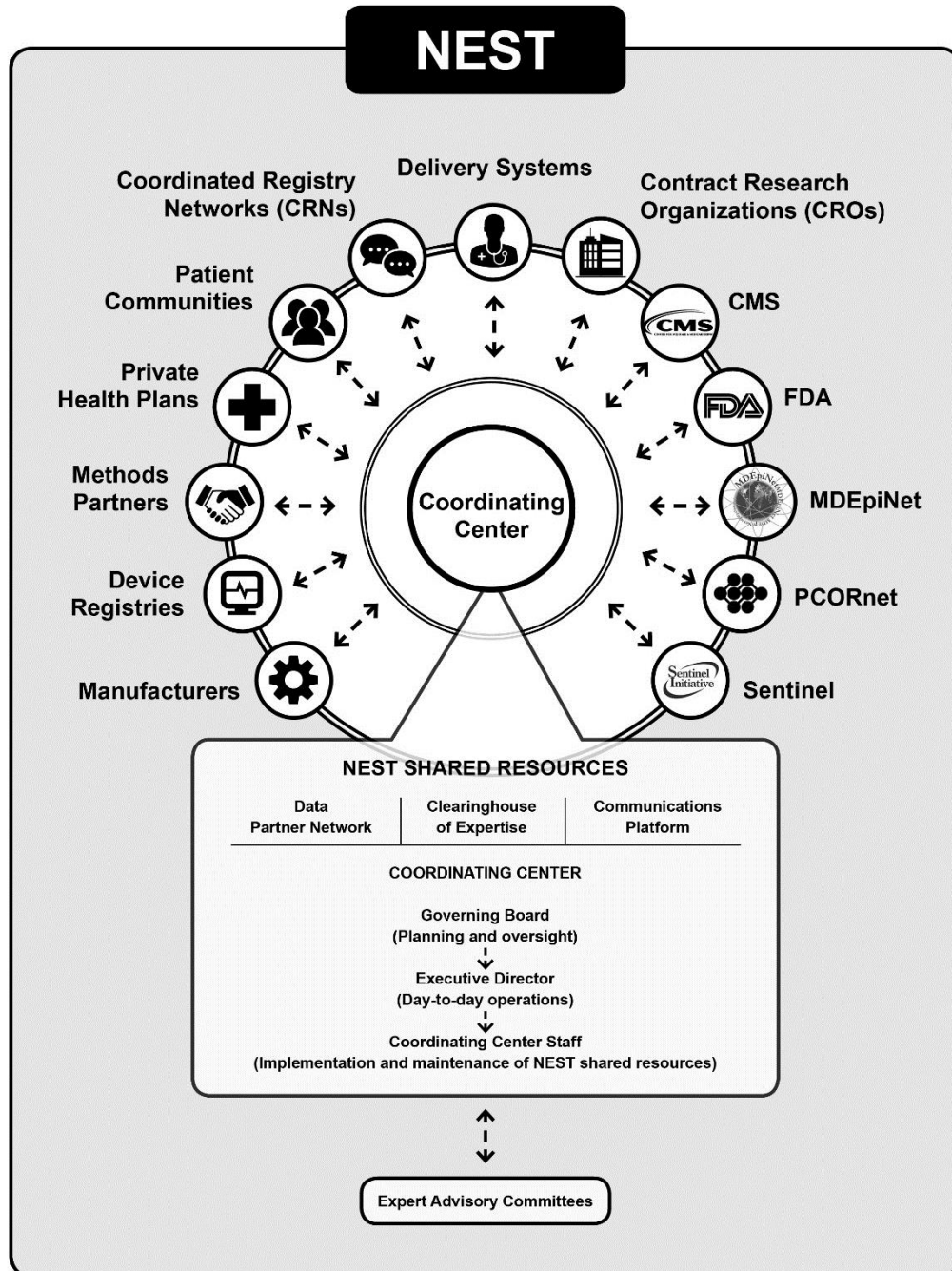
To develop the organizational bylaws and governance structure, the Coordinating Center will need targeted expert input on multiple technical, legal, and scientific issues. Small committees of external experts could be an important tool to provide advice to the developing organization. Once established, the Governing Board should evaluate the continued need for expert advisory committees to provide input on operational and governance issues such as patient protection and privacy, sustainable business models, and scientific and/or technical challenges.

ESTABLISHING THE GOVERNING BOARD

The Planning Board recommends that the Governing Board be a group of eleven to fifteen representatives to allow inclusion of the appropriate stakeholder representation but still be nimble enough to efficiently address organizational needs. The Coordinating Center bylaws will need to outline the selection criteria for the Governing Board and may need to allow for designated seats to ensure federal representatives are included. These bylaws may designate seats for other major stakeholder groups such as patients, industry, clinicians, hospitals, and health plans to ensure balanced representation, including fair representation of regulated entities. Board members should be term-limited to balance the need for sustained engagement with the responsibility to broaden participation and perspectives to help the Coordinating Center evolve with the changing needs of NEST.

This process for selecting the Governing Board should include a public call for nominations and an exhaustive outreach strategy to solicit applications from key stakeholder groups. The selection committee should include representatives of stakeholders such as patient groups, industry, clinicians, hospitals, payers, other data partners, researchers, and relevant government agencies. The selection committee should review, vet, and select the Governing Board members. Selection criteria should be balanced between the need for content expertise, ability to be a committed and trusted representative of their stakeholder groups, and commitment to provide the time necessary to fulfill their Governing Board duties.

GOVERNING BOARD OVERSIGHT RESPONSIBILITIES AND PRIORITIES

Once in place, the Governing Board will be responsible for guiding the strategic development of the Coordinating Center, providing operational leadership and oversight, establishing key policies, and building the underlying partnerships to develop and sustain the organization.

Bylaw Oversight: The Governing Board will have authority over the Coordinating Center bylaws. As the organization evolves, the Governing Board will need to determine when modifications to the bylaws are necessary and ensure that there is a process in place for obtaining stakeholder input on those changes.

Operational Oversight: The Governing Board should oversee the operations of the Coordinating Center. The Executive Director will directly report to the Governing Board. Within six months of the Governing Board's formation, the Board should select and vote to confirm a permanent executive director. The founding bylaws will outline the Governing Board's legal and fiduciary oversight authority and its responsibilities to the Coordinating Center.

The Governing Board will be responsible for setting strategic priorities for business development including the financial sustainability of the Coordinating Center. Ultimately, the success of the Coordinating Center will depend on building the shared resources of the system incrementally through cooperative re-usable processes that have value to the stakeholders who can provide long-term financial support to the Coordinating Center.

These include private partners that may pay fees-for-services or membership/subscription dues for continued shared infrastructure building and maintenance, as well as public support to fund those benefits that accrue to the public at large, rather than specific, companies or stakeholders.

Policy and Strategic Development Oversight: It is critically important that the Governing Board ensure that the Coordinating Center's policies support the activities of NEST and foster partnerships across stakeholder groups. Data governance is a high priority policy area given the need for the Coordinating Center to quickly establish a network of data partnerships. The Coordinating Center will need to set concrete rules outlining how data partners share information through the use of governance tools such as standardized data use agreements, data oversight, and reporting. Development of these policies will create a gateway that expedites access to data on medical devices while ensuring the responsible use of those data within the network of data partners. The policies should be grounded in NEST principles (Appendix A) and data governance criteria (Appendix C), particularly with regard to data interoperability, and commitments to rigorous privacy, ethical, and data security protections. Additional information on this topic is included below under "Building the Shared Resources of NEST."

COMMITMENT TO PATIENT-CENTERED GOVERNANCE

Creating NEST as a patient-centered system is a central component of the system mission and governance principles as laid out in the Planning Board's 2015 report and is therefore a priority for the Governing Board's leadership. Patient-centered healthcare research prioritizes patient preferences, decisions, and outcomes, and enhances the ability of healthcare delivery systems to respond to patient needs in everyday practice.[7] The Governing Board will need to ensure that patients and their needs are integral components of the Coordinating Center's organizational governance and project activities. FDA and CDRH made "partnering with patients" as one of its strategic priorities for 2016-2017.[8] While there is some variation in how stakeholders define the term "patient-centered," one bedrock principle that commands wide agreement is respecting patients' control of their data. Working with its partners, the Coordinating Center should establish an efficient accountability framework within NEST that reassures patients that their interests will be honored.

The Coordinating Center should define what constitutes patient-centeredness for NEST. The Coordinating Center should ensure that development of the governance policies, key activities, and demonstration projects meet this patient-centered definition. While there should be patient representation on the Governing Board, this will entail more than simply recruiting patient representatives to serve on NEST committees. It calls for innovative approaches to mobilize patients' voices and make activities and projects responsive to them. Early activities could, at a minimum, include collecting and promoting best practices on patient participation in device evaluation studies, as well as routine consideration of patient preferences and patient reported outcomes in study design and communications. The Governing Board should consider a standing expert committee to make annual evaluations on the Coordinating Center's performance in this area.

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The Coordinating Center should work with partners to build on FDA's efforts to incorporate the patient voice within regulatory decision making, such as the Patient Preference Initiative that works to include patient

perspectives in the FDA benefit-risk framework and issuance of draft guidance on patient preference information for use in device approvals and labeling.[9,10] The Coordinating Center should seek to partner with groups already working in this area. For example, the Medical Device Innovation Consortium (MDIC) has developed a Patient Centered Benefit-Risk Assessment framework for incorporating the patient perspective into medical device development, premarket approval, and postmarket evaluation using scientifically validated methods.[11]

The Planning Board believes that the Coordinating Center should participate in work on solutions to improve informed consent requirements and transmission. The Coordinating Center will work to ensure compliance with all federal and state rules and policies regarding patient protection across all NEST activities. The Department of Health and Human Services, along with 15 other federal agencies, has published a proposal to modernize the Common Rule, the regulation that has governed many categories of human-subject research since 1991.[12] This proposal continues to generate active debate and concerns about potential unintended consequences,[13] and a recent National Academy of Sciences report on research regulations called for the proposal to be withdrawn.[14] The Coordinating Center will be working in an environment where there may be important changes in the rules that govern how research institutions safeguard patient confidentiality, obtain informed consent, engage with institutional review boards, and apply a risk-based approach to oversight of research.[15] Moreover, the basic mechanisms for accessing data for health research may evolve and new models may emerge in coming years. For example, the HL7 standard for data segmentation for privacy (recently included in the Office of the National Coordinator for Health Information Technology's 2015 Edition Health IT Certification Criteria) enables tagging of Consolidated-Clinical Data Architecture document so that those data elements which can be disclosed are able to be separated from those which cannot due to specialized privacy rules. With rapid advances in technology for electronic consent management, additional mechanisms for accessing data may be developed and considered for the Coordinating Center activities.

The Planning Board recommends the Coordinating Center strive to be a leader within the medical device community by working with partners to evaluate emerging models for patient-centered data access and develop and promulgate a national strategy to ensure sustainable, ethical access to the data resources that the NEST will require. This strategy should account for prospective regulatory changes that may affect consent exceptions that have traditionally afforded data access under the Common Rule and Health Insurance Portability and Accountability Act (HIPAA) Privacy Rule, and also must be responsive to prospective changes in the types of research that will be important in the future (e.g., studies with no pre-specified hypothesis). The Coordinating Center also should work to facilitate further progress in ensuring individuals' access to and the ability to securely transmit their own data. This is a way to demonstrate respect for individuals in addition to acting as a data curation process and a driver of patient-mediated access to data for medical device safety research.

BUILDING THE SHARED RESOURCES OF NEST

The Planning Board's April 2016 paper recommended the creation of a Coordinating Center to develop and maintain the NEST shared resources:

- A virtual network of data partners, connected through re-usable, standardized data use agreements (DUAs), that permit access to data from multiple sources (including electronic health records, claims, registries[*], patient-reported outcomes, clinical trial data, etc.) to optimize data standardization, expedite

[*]CDRH defines registries as systems that collect and maintain structured records on a specific disease, condition, procedure, or medical product for a specific time period and population.

project-specific research agreements, and reduce the cost of evidence development through economies of scale;

- A clearinghouse of expertise and advanced methods, tools, standards, and best practices (e.g., to detect safety events and to study clinical effectiveness of new technologies for regulatory and reimbursement decisions);
- A trusted and up-to-date compilation of reliable information on the benefits and risks of medical devices for patients and the broader health community (e.g., FDA safety updates, recall management support, published effectiveness information).

These shared resources will allow the Coordinating Center to act as a facilitating body that provides organizations within the medical device ecosystem with voluntary cooperative opportunities and structured frameworks to drive down the time and cost of generating evidence on medical devices. The Planning Board recommends the Coordinating Center engage broadly with stakeholders and survey external activities and changes in public policies. This should inform both internal strategic planning efforts and demonstration project development that builds and maintains the shared resources, as well as developing the necessary governance and access policies.

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BUILDING NEST'S NETWORK OF DATA PARTNERS FOR DEVICE EVALUATIONS

When fully operational, the core of the NEST will be an interoperable network of data partners. This voluntary network will initially be created through standardized data sharing agreements. It is envisioned that the Coordinating Center will begin with a limited set of partners and expand as the governance policies and program processes are established. Early critical data partners include PCORnet, Sentinel, coordinated registry networks (CRNs), payers, large healthcare systems, claims data systems, the device industry, the National Center for Health Statistics (e.g., National Death Index), and patients to name a few examples. CRNs could provide useful models for the data-sharing agreements, as well as other prototype studies that have demonstrated the utility of this type of networked data from registries, medical claims, and electronic health record systems.[16] The Coordinating Center should also leverage efforts by CMS to promote use of registry information for regulatory purposes.[17]

As the network grows, the Coordinating Center will need to continually work with its partners to refine and update the digital infrastructure, governance, and incentive structure needed to collect and share medical information for device evaluations using real-world evidence on a routine basis. To maximize efficiency and effectiveness, the Coordinating Center should work with their partners to develop a comprehensive strategy focused on building re-usable[*] solutions to meet high-priority needs that support sustainable business cases.

The role of the Coordinating Center is to encourage re-useable, efficient, and transparent connections, but not create exclusive relationships for selected partners. The network will need clear governance policies that outline

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[*] Re-usable solutions are solutions that, at a minimum, are extensible to multiple medical devices and are ideally generalizable to multiple data networks.

the rigorous privacy, ethical, data management, and security protections required by federal and state law while assuring appropriate access to the network. The Coordinating Center should join with CDRH's and other stakeholders' existing efforts to promote standardized data use agreements, which could be used to promote broad collaboration between partners beyond the FDA. Standardization across registries, a key recommendation of the Registry Taskforce, is one potential early opportunity in this area.

A sustainable system requires that the network be able to efficiently collect, share, and link data. Advances are needed in the automated collection and extraction of data from routine clinical care that do not overly burden clinician workflow but increase the quality of data. Important developments in standardized electronic health information and improved interoperability have been undertaken by groups such as ONC and HL7. The Coordinating Center should seek to partner in the evolution of these efforts, which include building the business case and rules of engagement for sharing medical device information among major stakeholders using FHIR.[18,19] The Coordinating Center should prioritize demonstration projects that connect disparate data sources, and standardize and automate data collection through routine clinical and administrative workflows. Projects should also pilot governance policies regarding requirements for secure data access, storage and transmission, as well as processes for addressing informed consent requirements and transmission.

BUILDING NEST'S CLEARINGHOUSE OF EXPERTISE

The FDA commissioner and CDRH's director recently stated that access to electronic health data alone is not sufficient for NEST to become a sustainable, efficient system.[20] The Coordinating Center must also develop a strategic approach for "establishing core data sets, using common definitions, facilitating transfer and linking among interoperable data sources, and efficiently embedding research data collection into routine clinical workflow and participating patients' daily activities."[21] The Coordinating Center should work with communities of experts to support the development of a NEST clearinghouse of analytical tools, methods, and standards for using linked real-world data collected through clinical and administrative workflows as well as from patients themselves to evaluate devices. The Coordinating Center will also need to convene communities of experts to identify and promote the broader use of existing best practices and tools for medical device evidence generation and data sharing. The Coordinating Center should then develop web-based tools to provide access to this clearinghouse of shared knowledge and best practices.

The healthcare ecosystem is dynamic and quickly evolving to adopt new technologies and advances. It is essential that the Coordinating Center be part of that evolution by staying abreast of changes and opportunities to include emerging or current projects in the clearinghouse of methods and best practices. Examples of potential expert communities include the RAPID project, which is currently working to standardize core data elements to serve as a global case report form for evaluations of peripheral arterial devices,[22] and the DELTA (Data Extraction and Longitudinal Trend Analysis) System, which can provide near real-time active safety surveillance of clinical registry data.[23] The Coordinating Center's ongoing connections to these expert communities will be critical in establishing the Coordinating Center as a resource for fostering new projects and facilitating connections across different areas of expertise to encourage future collaborations. The Coordinating Center will also need to keep the NEST clearinghouse updated with information on new technologies and trends such as the Internet of Things, cyber security, mHealth, and next-generation diagnostics. For example, the Coordinating Center might partner with groups like ONC, the Medical Device Innovation, Safety and Security Consortium (MDISS), and FDA to support the development of a network of experts and tools to bolster current work on medical device cybersecurity.

Demonstration projects should make use of the expert communities and the burgeoning NEST clearinghouse to inform study design and governance, while the results of the demonstration projects themselves should inform the knowledge base of the clearinghouse.

DEVELOP A UDI NATIONAL IMPLEMENTATION STRATEGY

A critical component to enabling the efficient use of NEST is the presence of standardized device manufacturer and model information in real-world electronic health data, through Unique Device Identifiers (UDI).[*] Strategic planning and implementation efforts related to the FDA's Unique Device Identification System should include the multiple aspects of healthcare delivery systems, including supply chain management, clinical care, and financial administration, to leverage existing infrastructure. This is an area where there is an immediate need for the Coordinating Center to provide leadership. The Coordinating Center should lead the development of a national strategic planning process and build the community of cross-disciplinary experts to promote implementation of UDI into healthcare delivery systems.

While UDI is compulsory for manufacturers and labelers, there is no legal mandate for the use of UDIs in healthcare delivery. However, federal activities to encourage the adoption and use of UDIs are steadily increasing. In ONC's 2015 Edition Health IT Certification Criteria, ONC included technical criteria for recording UDIs for implantable devices and integrating this information in a patient's electronic health record. The criteria also require the capability to retrieve information about an implantable device by looking up a device's UDI in the FDA's Global Unique Device Identification Database (GUDID).[†] These capabilities are required for all health IT certified to the latest edition of ONC's health IT certification criteria

> The Coordinating Center should lead the development of a national strategic planning process and build the community of cross-disciplinary experts to promote implementation of UDI into healthcare delivery systems.

(2015 Edition Health IT Certification Criteria). In the 2015 EHR Incentive Program Final Rule, CMS also noted the importance of including the capability to record UDIs for implantable devices in the latest version of the certified EHR technology definition, which is the set of technology that an eligible provider is required to possess to participate in the EHR Incentive Programs.[24,25] In addition, both FDA and CMS support integrating the device identifier portion of the UDI into the next Accredited Standards Committee X12 claims form.[26]

The objectives of this national strategic planning process should be to: 1) identify the stakeholder community around UDI implementation into healthcare delivery system and develop roles for all stakeholders in implementation; 2) develop strategies for use of UDI in device evaluation and in NEST activities; 3) mobilize resources through the commitment of stakeholders and broader funding initiatives, and 4) monitor and track

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[*] A unique device identifier (UDI)is a unique numeric or alphanumeric code that consists of the labeler and the specific version or model of a device, and one or more of the following: the lot or batch number within which a device was manufactured; the serial number; the expiration date; the date manufactured; and the distinct identification code for a human cell, tissue, or cellular and tissue-based product (HCT/P). 21 CFR 801

[†] FDA issued the Unique Device Identification System final rule on September 24, 2013. 78 FR 58786. The rule implements a statutory directive to establish a "unique device identification system" for medical devices that will enable adequate identification of devices through distribution and use. 21 U.S.C. § 360i(f). Among other requirements, device labelers must include a UDI on the label and packages of most medical devices and must submit standard identifying data about those devices to the Global Unique Device Identification Database (GUDID).

UDI inclusion in real-world data captured in health care. Inclusion of UDI information into the work flow of healthcare delivery to support quality of care should be a key strategy for this planning effort.

This process should build on previous efforts to promote UDI implementation. In 2014 and 2015, the Brookings Institution and PEW Charitable Trusts released reports outlining specific strategies for UDI adoption within provider systems, administrative transactions, and patient-directed tools.[27,28] Previous research has identified gaps in and benefits of UDI use.[29,30,31,32] These publications and the positions of many stakeholders suggest that national UDI adoption will require multi-stakeholder collaboration, market incentives, and targeted public investments to spur the adoption of UDI into electronic health information systems. The ongoing Building UDI into Longitudinal Data for Medical Device Evaluation (BUILD Initiative) is focused on demonstrating, implementing, and applying UDI in health care as well as leveraging UDI to move information on devices to clinicians, researchers, and in support of device innovation, foundational efforts for NEST.[33]

Demonstration projects should showcase, for hospitals and other systems, the value of UDI implementation. The Coordinating Center should work to build the clinical and business case(s) for making strategic investments in activities critical to or benefiting from UDI adoption such as use of UDI in patient care, patient safety notifications, recall management, ongoing improvement in the quality of data in FDA's Global Unique Device Identification database (GUDID), and automatic identification and data capture (AIDC) technology.

DEVELOPING NEST'S MULTI-DIRECTIONAL COMMUNICATION PLATFORM

The Planning Board recommends that the Coordinating Center should support FDA's process for disseminating warnings and safety information. To do this, the Coordinating Center should create and maintain a platform for sharing FDA information in clear, accessible, and understandable language for patients, doctors, and caregivers. This shared platform could also be used by the device industry to communicate voluntary recall and related safety information.

Researchers working with the Coordinating Center's shared resources should be required to alert FDA and the manufacturer of potential safety signals in a timely fashion. It is important to validate these potential signals carefully, given that there can be tremendous variance in signals depending on data source and methodology.[34,35] The Coordinating Center will need clear policies and processes to address the appropriate next steps for any potential signals generated through Coordinating Center-related activities and should involve the FDA, the original researchers, and the device manufacturer(s). The policies should safeguard patient privacy, and provide appropriate protection of competitive interests and trade secrets that may be involved. Dissemination and communication policies should also seek to clearly explain both the benefits and risks of any potential actions available to stakeholders related to specific safety signals. As part of the Coordinating Center's commitment to transparency, these policies should also require timely publication in a peer-reviewed journal or, in the absence of this, dissemination through the Coordinating Center itself.

The communication platform could also allow the voluntary sharing of information on non-safety related results in clear and understandable formats using best practices in transparent and clear communication. Access to the platform could be limited to studies facilitated by the Coordinating Center and using best practices as defined by the clearinghouse of expertise. However, it will need to be clear that this information is being compiled for the convenience of patients and clinicians, and that the Coordinating Center has not validated the results.

Finally, as part of its commitment to transparency and accountability, the Coordinating Center will be responsible for communicating information about the mission, function, and methods of the Coordinating

Center itself. Operation and performance metrics for the Coordinating Center should be transparent and understandable to the general public, while respecting proprietary knowledge and stakeholder privacy. This will require policies, tools, and appropriate personnel to guide an internal communications strategy for the network of expert partners and other stakeholders within NEST, as well as an external strategy to effectively communicate with patients, the media, potential new stakeholders, the general public, and relevant government entities.

DEMONSTRATION PROJECTS AREAS

In the past reports, the Planning Board has recommended that the Coordinating Center drive the development and execution of strategically chosen and innovative demonstration projects in critical areas. This section describes priority areas in which the Coordinating Center should promote project proposals and funding that will build infrastructure for NEST (Table 1). The Planning Board's intent is not to endorse specific projects but to set out promising examples within high-priority categories for the Coordinating Center to pursue.

The success of NEST and the sustainability of the Coordinating Center depends on demonstrable achievements of strategic priorities shared by others in the medical device ecosystem and by pursuing initial projects and activities with a high likelihood of building the NEST shared resources.

In April 2015, the Planning Board recommended that the first phase of demonstration projects identify partners, tools, and methods that could quickly be leveraged to pilot the Coordinating Center's cooperative approach to using NEST by expanding to new therapeutic areas and/or be scalable on a regional or national basis. The Planning Board also recommended that the Coordinating Center start planning the second phase of projects immediately. Phase two projects are more likely to explore the viability of novel new analytical and data sharing methods. They are also more likely to build on existing programs that are relatively early in their development. Given the additional preparation time needed for these projects, the Board has recommended that these projects be initiated by the end of the second year and completed by the fifth year.

Demonstration projects will serve as early tests of Coordinating Center governance and the scaling and generalization concepts necessary for building the NEST shared resources. The Planning Board recommends that the Coordinating Center evaluation of potential projects be based on three considerations: impact, feasibility (including implementation time), and contribution to Coordinating Center sustainability.

TABLE 1. POTENTIAL DEMONSTRATION PROJECT AREAS

Phase 1	Balancing the transition from pre- to postmarket evidence generation
	Increasing the efficiency and quality of safety surveillance
Phase 2	Increase ability the support evaluation of class II devices
	Patient-mediated data sharing
	Supporting assessments of value for medical devices

IMPACT

The impact assessment of a demonstration project should include a reasonable estimate of the project scope, scale, and benefit to one or more of the major stakeholders in the national system. Promising projects should benefit patients, create efficiencies to make studies more affordable, promote patient engagement, and facilitate robust communication between stakeholders. Pre-specified evaluation metrics should include performance and cost.

FEASIBILITY

Assessment of project feasibility should be based on access to funding and a high likelihood of completion within pre-specified timelines. As was recommended in April 2016, first phase demonstration projects should begin during year one of operations and be completed by the end of year three. Given this timeline, it is likely that projects selected will need to leverage promising projects already underway. Because implementation challenges will arise when scaling up the building blocks, the Coordinating Center should reserve time and effort in the development plan to resolve these problems.

> The success of NEST and the sustainability of the Coordinating Center depends on demonstrable achievements of strategic priorities shared by others in the medical device ecosystem and by pursuing initial projects and activities with a high likelihood of building the NEST shared resources.

Project selection will also need to balance value to individual stakeholders who may be interested in funding specific pilots with overall value to the healthcare system and NEST. This balancing of priorities should be sufficient to attract funding from stakeholders without unduly limiting the focus of the projects. The Coordinating Center will need to test and adapt its selection criteria as necessary.

CENTER SUSTAINABILITY

The sustainability of the Coordinating Center will depend on: (1) the successful execution of pilot projects to develop shared resources that create efficiencies for stakeholder device evaluations; (2) establishing a reputation as a trusted authority and partner; and (3) demonstrating sufficient value to stakeholders to warrant investment or support. Demonstration projects should support the development of reusable platforms (partnerships, infrastructure, and methods) capable of providing meaningful information to major stakeholder groups, especially patients. Demonstration projects should also address gaps and opportunities in the current system of medical device evaluation and create solutions where methods currently fall short.

The sustainability of the Coordinating Center will also depend upon building and maintaining a reputation as a trusted resource and expert community, one that consistently meets the needs of the public and sponsors. It is essential that Coordinating Center activities are aligned with and supportive of the NEST mission and principles.

PHASE ONE DEMONSTRATION PROJECT AREAS

Given the short timeline for initiating and completing the phase one demonstration projects, the Planning Board recommends that these projects build on current successful initiatives and seek to expand their scope by linking to new data sources, applying new analytical methods to address different health questions and/or reducing

unnecessary administrative burdens. The Planning Board's April paper recommended that early demonstration projects enable better surveillance and regulatory decision-making and be guided by FDA device evaluation priorities.

BALANCING PREMARKET AND POSTMARKET EVIDENCE GENERATION

GOAL

NEST should allow sponsors and FDA to efficiently use real-world evidence for appropriate regulatory purposes. Initially, these methods should be explored through national registries, which contain standardized real-world data that has been verified through audits and detailed information on devices used. Eventually, these methods may be expanded to electronic data automatically extracted from claims, EHRs, and other sources using UDIs to evaluate devices not typically tracked through registries in a timely and efficient manner.

PROPOSED APPROACH

Manufacturers conduct premarket clinical studies of investigational devices (under the "Investigational device exemption (IDE)" provision) to demonstrate the safety and effectiveness of devices. Postmarket studies have been used as an effective tool to reduce the need for some premarket data collection while maintaining the same standard for assuring reasonable safety and effectiveness, allowing new and innovative devices to reach patients faster. However, postmarket studies often encounter difficulty recruiting patients to participate and often lose a large proportion of patients to follow-up, leading to delays in study initiation and completion.

Embedding IDE studies into registries from the premarket stage may be a solution for some types of medical devices, allowing a more seamless transition from pre- to postmarket data collection. There are multiple advantages to embedding a pre-market IDE study into an existing postmarket registry.[36] Registries routinely collect and transmit electronic data related to the device, and Institutional Review Board(s) (IRB) are familiar with the registry's patient protection elements. Stewards for multi-device registries run by professional societies and others often have valuable information on the quality of investigators and clinical sites, which is necessary for accurate and complete data collection. Quality improvement measures built into registries enable a more granular assessment of factors contributing to adverse events, such as clinician or patient factors, while also adding additional incentives for participants. During the approval process, reviewers have the assurance that additional data will be available in a timely manner on the performance of the device in a broader population and/or over a longer time period. Depending on the premarket study design and the registry, there may also already be data use agreements in place to obtain longitudinal outcome information from claims data.

However, registry-embedded IDE trials are a relatively new idea and best practices are still needed to inform the unique requirements for designing and completing them. Embedded IDEs within registries may require data elements not normally included in the registry, including imaging data and follow-up assessments to determine therapeutic outcomes. Work has been done on modular add-ons to the core registry data set to address this issue. Sponsors would still be responsible for site selection, training, informed consent, and timely follow-up data collection. If requested, the Coordinating Center could connect sponsors with expertise on ensuring the absence of selection bias and the integrity of randomization, where required, at the site level. There may be unique questions that arise with data collection when utilizing embedded IDEs. For example, who has access to the data for publication and regulatory purposes? Does the sponsor have shared control and access to the registry data, or should they be sent periodic updates? Guidance is also needed on the potential use of registry

data by manufacturers on common off-label uses of their devices as evidence for label expansion. Facilitating a project that builds on previous work in this area will allow the Coordinating Center to build NEST's shared resources by piloting governance policies and data use agreements for the network of data partners to collect and link detailed procedural data and longitudinal outcomes, and expanding and promoting best practices in methods for this type of study.

SUPPORT A PROSPECTIVE REGISTRY-EMBEDDED TRIAL OF A NEW DEVICE

There are several recent examples of prospective, randomized studies embedded in registries that a demonstration project could leverage. Both the Society of Thoracic Surgeons /American College of Cardiology Transcatheter Valve Therapy (STS/ACC TVT) Registry and the National Cardiovascular Data Registry (NCDR) have hosted embedded-IDE studies for potential label expansions.[37] The SAFE-STEMI project is the first known prospective, randomized embedded-registry IDE trial designed to be used for an expanded indication regulatory decision.[38] The trial is using NCDR CathPCI Registry with supplemental data sent by the provider system sites. Embedding the trial into the registry saves provider systems time that would otherwise be spent completing a traditional trial case report form, as much of the information in the trial case report form is pre-populated from the registry case report form.

The Planning Board recommends that the Coordinating Center take the next step and partner with a mature multi-device registry, provider system(s), and manufacturer(s) to facilitate a prospective embedded-IDE trial within a registry to support the approval of a novel medical device. The project should involve identifying best practices to ensure embedded-IDEs trials are safe and methodologically sound. The demonstration project should also include piloting generalizable methods for linking longitudinal outcome data to the registry and auto-population of case reports from routinely-collected EHR data. An important governance aspect of this project could be to pilot methods to obtain and transmit informed consent for registry trials, potentially including unspecified additional studies on the data collected during the IDE trial.

EVALUATE BEST PRACTICES AND LIMITATIONS OF RETROSPECTIVE STUDIES USING REAL-WORLD DATA

Retrospective analyses of registry data have previously been submitted to the FDA in support of pre-market submissions. For example, FDA approved a label expansion of the Edwards SAPIEN atrial valve device using retrospective registry data. Specifically, the SAPIEN device was approved for implantation using an alternate access technique in inoperable as well as high-risk patients.[39] Currently, this type of analysis is reviewed for patient protections by an IRB and FDA. The Coordinating Center should evaluate current processes for ensuring patient protections within existing regulatory frameworks, and recommend best practices for using registry data in device research and regulatory submissions, including ways to link registry information to supplemental data from other sources. A subsequent pilot could assess the feasibility of more standardized approaches for conducting these type of analyses.

INCREASING THE EFFICIENCY AND QUALITY OF SAFETY SURVEILLANCE

GOAL

NEST will ultimately enable the generation of timely and meaningful information about medical device safety signals through complementary systems. One potential system could use networked data to actively automate collection and assessment of rate-based changes in labeled outcomes through real-world data captured in the

normal workflow of clinical care. Another system could assist clinicians and patients in producing high-quality, usable reports on the unexpected, serious, and/or rare events that would not be captured in an automated system.

PROPOSED APPROACH

Multiple stakeholders have indicated that facilitating methods to increase the quality of medical device surveillance while reducing the burden of Medical Device Reporting (MDR) should be a priority for the Coordinating Center. Initial demonstration projects should take advantage of ongoing work by FDA, MDEpiNet, and others working in this area by evaluating previous efforts to find where gaps exist and developing recommendations on best practices. The Coordinating Center should then facilitate projects that expand the use of successful methods into new therapeutic areas, automate and standardize processes when possible, and link additional data sources where useful.

MDRs serve as a critical component of FDA's postmarket adverse event reporting system. FDA receives over a million MDRs every year for reportable device malfunctions and device-suspected adverse events, including those involving injury or death.[40] Since voluntary MDR reporting began in 1973, FDA and manufacturers have used the MDR system to identify emerging safety signals and correct issues with medical devices that have protected numerous patient lives.[41] Passive surveillance will continue to be useful in reporting unexpected, rare, and/or serious adverse events, documenting the effectiveness of corrective actions, understanding types of malfunctions/events for a given device or device category, and identifying human factor issues. However, not all reportable adverse events that occur are sent to manufacturers and those initial reports can be incomplete, making it difficult for companies to get a full understanding of what occurred. Also, the lack of exposure data (the denominator) makes understanding the potential scope of the problem difficult.

The Coordinating Center should facilitate demonstration projects that work to make the passive system more efficient and transfer some surveillance of common adverse events into automated active surveillance systems. Novel active surveillance methods such as the DELTA System uses registry data, sometimes combined with longitudinal outcomes, to make signal detection faster. Tools that facilitate efficient capture of high-quality initial reports from providers may encourage higher levels of relevant reporting. In addition, alternate pathways for manufacturers to efficiently report common labeled outcomes in individual quarterly summaries may facilitate FDA trend line analyses. Summary reports on labeled outcomes utilizing information from a registry with full coverage of a patient population or a representative sample could also include rate-based information.

PROMOTING BEST PRACTICES IN AUTOMATED SIGNAL DETECTION AND ANALYSIS

Signal management describes the process used to analyze and respond to potential concerns or signals identified in medical devices. Reducing the time to identify potential signals could lead to earlier investigation and, if necessary, earlier corrective actions by FDA and device industry. This could limit patient exposure to underperforming or harmful devices. Automated signal detection software such as the Data Extraction and Longitudinal Time Analysis (DELTA) system has been piloted in several cardiovascular registries, demonstrating the potential to detect safety signals in near real-time.[42] However, initial safety signals detected by these methods must also be evaluated and analyzed carefully to avoid the risk of false positive or misleading signals. On the drug side, the Duke University Health System's Automated Adverse Drug Event Detection and Intervention project developed an integrated system for automated adverse event detection and trend line analysis.[43] The novel surveillance system leveraged information systems at three participating hospitals to

automatically detect potential adverse events. However, it has not been tested for detecting adverse events potentially related to devices.

The Coordinating Center should partner with FDA, real-world data systems, provider systems, and the device industry to facilitate development of best practices around the use of automated signal detection methods. This project should evaluate methodology for validating and verifying signals, and make recommendations for how best to implement active surveillance software into provider or registry systems, including recommendations around data quality. The Coordinating Center should develop recommendations around transparency for signal analyses evaluated by NEST, and share best practices for effectively communicating to stakeholders both the methods used and any significant results. These recommendations and the lessons learned from previous automated surveillance pilots should be documented in a roadmap. Since the demonstration project will require both specific device information and information on a large number of patients, partnering with a registry would be practical in the absence of broad UDI integration. However, it may be useful to explore these automated signal techniques in new therapeutic areas.

EXPANDED AUTOMATED ADVERSE EVENT REPORTING

Developing automated adverse event reporting systems was one of the central recommendations FDA made in their 2012 report "Strengthening Our National System for Medical Device Postmarket Surveillance".[44] The Coordinating Center should seek to expand the ability of provider systems to automatically generate MDRs with user-friendly technology to increase data fidelity and quality, including complete device identification. Reducing the time needed to report adverse events will save time for provider systems and may encourage more high-quality reporting, which could identify problems sooner.[45] Manufacturers would also benefit from higher quality initial reports that include more pertinent information. Eventually it may be possible to automatically transmit information from EHRs in such a way that active surveillance will be possible in the absence of a registry.

The results of a device-based pilot sponsored by CDRH called Adverse Event Triggered Event Reporting for Devices (ASTER-D) were recently published.[46] The investigators found that automated adverse event reporting could reduce time spent in completing the reports while improving the structure, standardization, and completeness of the submitted data. This pilot was done in conjunction with the Mercy UDI pilot,[47] and specific device information, including lot number, was also automatically entered into the report. The report also had space for additional information to be added and was reviewed by the provider system before transmission. While proof-of-concept was demonstrated, additional testing of the ASTER-D system with more events, multiple sites, and for generalizability to multiple device types must be done before firm conclusions regarding the scalability, value, and utility of the system can be drawn. In addition, the methods used in the original study did not allow FDA to receive supplemental reports electronically. The Coordinating Center could find funding partners and host provider systems who are interested in partnering to expand this work. Best practices should be documented for mapping information in the provider system's EHR into FDA's electronic submission form and securely transmitting the information. Enabling efficient and scalable expansion of the system should be a key component, so the Coordinating Center should also ensure major health IT developers are partners in this project. Device manufacturers should also be involved to ensure that all attainable information is documented to assist in their investigation of a reported adverse event.

EVALUATING SUMMARY REPORTING

FDA and manufacturers have explored pilot programs that allow periodic summary MDRs. In August 2015, FDA solicited participants for a pilot program which would allow quarterly submissions of malfunctions for class I and certain class II devices* in summary format.[48] Periodic summary reporting for adverse events captured in national registries have also been explored, although individual MDR reports would still be required for adverse events that either are not captured by the registry, or represent great public health risk. This type of reporting can streamline the reporting and analysis of commonly known issues for industry, FDA, and patient groups. For the minority of devices with national registries that contain complete patient coverage or representative patient populations, exposure data could be combined with summary MDRs to calculate valuable rate-based information.

The Coordinating Center should support FDA's work in this area by facilitating evaluations of time and cost savings achieved by shifting from individual MDRs to summary MDRs and other mechanisms that would potentially provide more accurate and actionable information. Quality measures, such as response time from initial signal generation to final resolution, should be included in potential projects. Best practices for summary reporting should be developed to promote consistent reporting procedures. This work should then be combined with meta-analyses of other research on this topic to produce recommendations regarding expansion of summary MDR programs.

PHASE TWO DEMONSTRATION PROJECT AREAS

As mentioned above, there were several priority areas identified by the Planning Board where specific projects will take longer than phase one projects to develop, initiate, and complete. These projects should be considered for inclusion in the second phase of demonstration projects or later activities. The Planning Board recommends that development and planning for these projects begin immediately given that it is expected that second phase projects will begin by the end of the second year and completed by the fifth year. Similar to phase one projects, these projects should leverage and advance successful pilot activities to expand their impact and utility.

INCREASE ABILITY TO SUPPORT EVALUATION OF CLASS II DEVICES

Class II devices make up almost half of registered medical devices, representing a huge range of devices including certain implanted devices like surgical mesh, imaging equipment, surgical devices, feeding pumps, and ventilators.[49] Most Class II devices are cleared through the 510(k) process, which requires manufacturers to demonstrate substantial equivalence to a legally marketed, non-PMA device. While these devices are generally considered moderate-risk; injury, death, and other unanticipated adverse events can still result, as demonstrated by recent high-profile events (e.g., power morcellators and duodenoscopes).[50,51] The current lack of UDI in clinical systems for Class II device models and the rapid iteration of device technology makes it challenging for regulators and manufacturers to quickly verify and validate safety signals. This also makes it difficult for patients, clinicians, hospitals, and payers to evaluate device benefits and risks.

To address these issues, the Coordinating Center should facilitate pilots that promote collaborative efforts to capture Class II medical device data in EHR systems and develop methods to better evaluate the safety and effectiveness of Class II devices using real world data. Common data models, standardized outcome measures

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* Eligible class II devices could not be permanently implantable, life supporting, or life sustaining.

and definitions make it possible to more accurately combine data while driving down costs and expediting evaluations. The diversity and scope of Class II devices may also require the Coordinating Center, working with expert communities, to identify novel analytics that support evaluations of safety and effectiveness for Class II devices. The Coordinating Center will need to facilitate collaboration between NEST partners capable of identifying, testing, and scaling technology and methodologies that efficiently capture and link Class II device data (including UDI) and electronic health information (EHI) for safety and effectiveness evaluation. A phase two demonstration project would benefit from identifying a therapeutic area with high utilization of higher risk Class II devices, such as infusion pumps, respirators, etc., that generally lacks systematic data collection (e.g. well-developed registries) to pilot alternative approaches to demonstrating improved safety, effectiveness, care quality, and operational efficiencies.

In addition, because many Class II devices digitally interface with other devices or computer networks, the Coordinating Center could consider identifying partners to pilot cyber-surveillance and cyber-safety methods for inter-connected devices. The National Health Technology Cyber Surveillance and Safety Network, a collaboration between MDISS and National Health Information Sharing and Analysis Organization (NH-ISAC), is developing an active surveillance system that focuses primarily on digitally-enabled connected class II devices.

PATIENT-MEDIATED DATA SHARING

Clinician researchers often face challenges in implementing effective forms of patient engagement in clinical research. Patients are often not fully informed by investigators of the risk and benefits associated with clinical research, have limited input into the study design and study outcomes, and generally receive little information on the research results.[52] In addition, the cost and resources needed for recruiting, obtaining consent, and engaging patients in clinical research can be burdensome at scale.

Alternative models of patient-mediated data access are emerging as patients gain more robust rights to access their own health data, which they can then share directly for use in device safety research. The Coordinating Center should pilot flexible, patient-centered approaches that support effective patient engagement in clinical research while also scaling the ability of major stakeholders to gain responsible access to patient data. The Coordinating Center should evaluate new approaches such as the "patient-driven data commons," a novel framework that allows patients to contribute data and collectively decide through a board which studies can use the collective data resources. [53] Patients voluntarily contribute access to their health information to the commons' control. The patients then elect a board to make decisions about which studies and which researchers can use the collective data resources, instead of each patient exercising specific consent for each study. Alternatively, the system could be configured around specific patient communities and individual consent. The Coordinating Center should facilitate a partnership between an active patient population, provider system(s), and medical device manufacturer(s) to build a patient-centered data commons platform. The pilot should evaluate the ability of the platform to improve the ability of patients to share their personal health information (PHI), consent to longitudinal device research, and receive high-quality information on the study results.

The Coordinating Center should build upon existing efforts and integrate best practices into a device-and-patient focused demonstration project. Several current examples exist that could be used as technical building blocks for this project. The Function and Outcomes Research for Comparative Effectiveness in Total Joint Replacement and Quality Improvement (FORCE-TJR) is a registry that primarily collects data from patients, including patient-reported outcomes of pain and function, early post-operative adverse events, and implant failures.[54] NIH, ONC,

and Harvard Medical School are leading the Sync for Science™ pilot to develop methods to facilitate individually-controlled clinical data donations to the NIH Precision Medicine Initiative (PMI) Cohort Program.[55] Another example is the Patient-Centered Information Commons: Standardized Unification of Research Elements (PIC-SURE), which was established to develop systems for the integration of multidimensional data, including environmental, behavioral, clinical, imaging, and genetic data to facilitate improved prevention and treatment outcomes and is working on a cloud-based web application to create a secure and unified registry for rare diseases.[56] Additionally, the Coordinating Center should explore other tools that enable patients to securely transmit their continually updated EHR and patient-reported outcome data to researchers they select.[57]

SUPPORTING ASSESSMENTS OF VALUE FOR MEDICAL DEVICES

The US healthcare system is rapidly evolving with an increased focus on providing high-value care that improves patient outcomes. Providers, payers, policy-makers, and other stakeholders are seeking new innovative approaches to delivering care that meets patients' needs while managing healthcare costs. New alternative payment models such as accountable care organizations (ACOs), patient-centered medical homes (PCMHs), and bundled payments tied to value-based incentives seek to reward quality and better outcomes in lieu of volume and intensity and are currently being implemented by providers and payers. Value-based insurance designs (VBID) and value- or outcomes-based purchasing agreements are also being explored and tested with the intention to improve overall quality of care while controlling unnecessary costs. Common to all of these efforts is the need for efficient and high-quality data that can measure and track effectiveness, quality, costs, patient-centered outcomes, and other components of value that are reliable, relevant, affordable, accessible for use, and trusted by all stakeholders.

As part of this shift in the healthcare ecosystem, there is increasing pressure on device manufacturers, providers, and payers to demonstrate not just device safety and effectiveness, but also the incremental value and quality gained by using novel medical devices. One significant challenge is lack of alignment across stakeholder groups, including patients, on the best measures of patient-centered value. Another challenge is that these data typically exist in disparate data sources such as claims, EHRs, and registries and are difficult to standardize, integrate, and collect routinely in ways that would enable efficient utilization of the data to measure quality and value.

The Coordinating Center should ultimately support and facilitate efficient and routine collection and use of device data that can be used in measuring value. The Coordinating Center should work with key stakeholders to identify measures of value and effectiveness that could serve as the basis of evidence needed to support new value-based reforms. Supporting pilots that are aimed at development of more efficient data collection approaches for measuring value throughout the life-cycle of a product should be included in the Coordinating Center's phase two pilots.

CONCLUSION

The Planning Board believes that improving medical device evaluations in a public health and national priority. The Coordinating Center has a unique opportunity to stand at the nexus of patients, organizations, and technology to drive investments into sustainable solutions for better medical device evidence and ultimately better care for patients. It should be clear that while the Coordinating Center itself will not fully constitute nor unilaterally govern NEST, it will play an important role in guiding the growth and maintaining the shared resources of the system. The Coordinating Center will need to identify how different stakeholder incentives can

be aligned towards the common goal of increasing the efficiency of the national healthcare system through innovation and shared learning.

Moving forward, it is important that the Coordinating Center establish itself as a trusted authority among stakeholders and the public. High-level governance principles, like those set out in this and previous reports by the Planning Board, should guide the continuous development of the Coordinating Center. The Coordinating Center will need to focus on establishing a clear governance structure driven by a representative Governing Board that is transparently selected. The public-private partnership nature of NEST will require high levels of engagement by federal partners, supported by policies enabling federal representatives on the Governing Board, and fair representation of stakeholders.

The Coordinating Center should begin work on demonstration projects as soon as possible. These projects provide the opportunity to communicate the capability of the Coordinating Center, and by demonstrating valuable use cases for a cooperative approach to building and using the NEST shared resources. The phase one demonstration projects concentrate on regulatory and safety improvements possible with a coordinated approach in analyzing real-world data. Second phase projects will expand this work into gaining a greater understanding of medical devices' value to various stakeholders, which will have implications for improving products throughout their total product life cycle.

This is an exciting and critical time in healthcare, and the Planning Board believes that the emerging electronic healthcare infrastructure can support a collaborative system capable of supporting the development, regulation and use of innovative medical devices. This system has the potential to improve public health and individual patient care by minimizing the time and cost of generating high-quality information on the risk, benefits and overall value of medical devices using real-world data captured through routine care. Significant progress has been made in the last decade across the health care system to electronically capture this information. By building the system using existing public and private sector infrastructure, NEST will leverage the experience and resources gained while the Coordinating Center works to ensure a harmonized national approach to improving evidence generation.

The Planning Board proposed the following mission, functions and system principles for a national evaluation system in their 2015 report. The National Evaluation System for health Technology (NEST) mission is ***to support optimal patient care by leveraging the experiences of patients to inform decisions about medical device safety, effectiveness, and quality in order to promote the public health.***

The Planning Board envisions NEST supporting the generation of timely and reliable information on medical device benefits and risks by coordinating a national data infrastructure that uses data captured as a part of routine patient care. Information generated through NEST should meet priority public health and healthcare needs related to medical device safety and effectiveness, including:

- Providing better information to support patient, clinician, health system, and payer decisions (including earlier reimbursement) about medical devices,
- Informing CDRH's regulatory decision-making to ensure safety and accelerate product innovation (facilitate premarket approval/clearance and expansion of indications for existing devices),
- Mitigating potential harms by supporting rapid response to device safety problems,
- Gathering information about existing products to inform the development of new and innovative devices, and
- Improving health outcomes through better decision-making based on information from real- world experiences with medical devices.

To accomplish its mission, the Coordinating Center should build NEST based on the following set of core principles:

GUIDED BY FDA DEVICE SURVEILLANCE PRIORITIES

While we envision that NEST will reflect collaboration among a range of stakeholders, data sources, analytic methods, and users, it is critical to keep in mind that the system will initially be implemented to address critical questions on the benefits and risks of devices that cannot be adequately addressed using existing tools. For this reason, FDA will play a critical role in identifying the specific questions that should be addressed through NEST.

PATIENT- AND CLINICIAN-FOCUSED

Patient needs and perspectives should be a central component of surveillance activities. NEST should support the capacity to generate information that addresses surveillance questions of high interest to patients and the clinicians that care for them. The system should promote mechanisms for patients to contribute information (e.g., performance, safety, and quality of devices they receive, care experience). NEST should also support timely and transparent dissemination of meaningful information to patients and clinicians to help inform decisions about their care. As providers of patient care, clinicians need a system with which they can obtain up-to-date information about the medical devices they use and to which they can provide medical device data based on patient care. To help assure these capabilities are achieved, patients and clinicians should be well represented in the leadership and management of the system.

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* From the Planning Board 2015 report "Strengthening Patient Care: Building an Effective National Medical Device Surveillance System" Brookings Institution, Washington DC

INTEGRATED COMPONENT OF A BROADER NATIONAL EFFORT

Consistent with the objectives of the learning healthcare system, NEST should be developed as an integrated component of a broader national health evidence development infrastructure. The Planning Board believes that any effort to create a standalone, isolated system will significantly increase the work required to develop data and conduct analyses on surveillance, lowering the value of the system and threatening its viability. The system should partner and collaborate with other health evidence development efforts to ensure that the various systems are aligned and complementary. Close connections to other health evidence development groups should promote the cross-pollination of expertise, methods, and technological advancements. The system should also leverage existing and developing health information technology standards and health information exchange infrastructure that is supported by the work of ONC to minimize duplication, cost, and time to capture and make data available for the system. The Planning Board should collaborate with health information exchange governance entities to enable use of existing systems and frameworks for NEST.

MULTI-STAKEHOLDER COLLABORATION

NEST is expected to use data generated by many different stakeholder groups—patients, consumers, clinicians, providers, payers, the device industry, public health agencies, and researchers—for a variety of different functions. These same stakeholders will also make use of the information generated by the system. All stakeholders should be engaged in the leadership of the system. In many cases, uses of much of the data by NEST will be secondary to the primary purpose of the source data (e.g., administrative claims, EHRs). In developing policies for using these data, the system leadership should be representative of the diverse stakeholder groups, including the data holders who have knowledge and expertise regarding the source data and can also provide input on the type of information and value that can be derived by the system, and seek to balance their needs and viewpoints with those of patients and the public.

Fulfilling a clear and focused mission given a variety of competitive interests and needs of the stakeholders is an acknowledged challenge, as is engagement and collaboration between different stakeholders. The leadership must be tasked to set the priorities and manage stakeholder expectations and demands to avoid mission creep and maintain the integrity of the system for optimization of patient care and promotion of public health.

FORWARD-LOOKING AND CONTINUALLY EVOLVING

NEST needs to support the ongoing evolution of, and access to, high-quality electronic health information. The system may start with limitations in its capabilities, but should have the capacity to advance with the healthcare ecosystem to maintain viability and value. It should seek to stay abreast of technological and methodological innovation and to drive programmatic and policy changes through technical expertise and leadership.

CLEAR EXPECTATIONS AND TRANSPARENT COMMUNICATION

Trust in the policies, methods, tools, leadership, and expertise of the people responsible for collecting, using, and disseminating findings is critical to the success of the system. The system leadership and governance needs to clearly establish the criteria and expectations for participation and uses of the data. This includes parameters about the types and quality of data utilized by the system, clarity about the methods and the development process, how to participate in the system, how data are used and handled, and criteria for publicly disseminating findings. The system leadership must also have mechanisms in place to identify, mitigate, and address real or

perceived conflicts of interest. Public support and trust will be founded on the timely and accurate communication of medical device benefits and risks.

MAXIMIZING UTILITY AND MINIMIZING BURDEN

NEST should be cognizant of the balance of providing more data and the burden of collection. In order to support the development of more meaningful information, the system should promote stakeholder collaboration to identify mechanisms to seamlessly integrate data collection into the provider-healthcare systems, claim system workflow, and as an integral aspect of care delivery.

As we have noted, creating a surveillance infrastructure for a single purpose limits its long-term utility and viability. The data within the system has the potential to support a broad range of evidentiary needs for a variety of stakeholders. In addition to using these data to support surveillance throughout the total product lifecycle, other important health questions could also be addressed. NEST should work to understand these other use cases and value propositions, coordinate with the responsible external groups to align work where possible, and identify opportunities to streamline reinforcing initiatives.

RESPECTING AND PROTECTING DATA PRIVACY AND SECURITY

Activities involving use of electronic healthcare data are subject to regulations administered by the HHS, including the "Common Rule" administered by the Office of Human Research Protections (OHRP), and the "Privacy Rule" and "Security Rule" administered by the Office for Civil Rights (OCR) under HIPAA. The system should actively work to ensure that federal and state patient-privacy laws, regulations, and ethical standards are maintained within the system.

While transparency will be the goal of the activities conducted using the national system, some information shared by third parties and collaborators will need to be kept confidential, including, but not limited to, individually identifiable health information, proprietary information disclosed by system collaborators, and data and communications concerning uses and outcomes of the national system that are not yet made public.

APPENDIX B: GOVERNING BOARD GOVERNANCE PRINCIPLES AND PRIORITIES[*]

The Governing Board will be responsible for building and maintaining the trust and confidence of all stakeholders. The Planning Board's 2015 report outlined a set of organizational governance principles that should be the foundation of the Governing Board's policies leading the Coordinating Center.

ADDRESSING CONFLICTS OF INTEREST

In building a multi-stakeholder organization, diverse views and priorities will be inevitable, and the organization will need to manage different, and potentially competing, interests. It is essential to have transparent conflict of interest disclosures and processes for the organization and its leadership.

CREATING PUBLIC TRANSPARENCY

The organization should be transparent in how it operates and communicates priorities, methods, and outcomes to the public. The governance policies should set specific conditions for accessing data. The organization should strive to communicate system-generated analyses and reports to the public, while adhering to patient privacy regulations. The organization should develop policies and procedures for public dissemination of findings. For example, results that may have significant public health implications should be made public. The organization should develop criteria and policies to annually report on its performance to the stakeholders and the broader public. These reports should include updates on the organization's operations, finances, governance, and organizational outcomes. The organization should seek to disseminate information developed through the system with the public. It will be imperative for the organization to engage the non-expert community. Particular attention should be paid to ensuring patients and consumers are engaged with the system, and communicating with them to demonstrate its value.

DEVELOPING RELIABLE DATA AND METHODS

The organization will need to develop policies to assure the integrity of the data accessed within the system. The organization should work with national experts to develop policies and criteria to assure the quality and appropriateness of the methods used in data generation, analysis, quality assurance, and dissemination. The organization should regularly evaluate the effectiveness of these policies and processes to maintain high scientific standards.

DEFINING VALUE TO ENSURE SUSTAINABILITY

The system will only be sustainable if it offers services and products that are valuable (functionally and/or financially) to participating stakeholders. The Board has identified two related dimensions of sustainability. The first refers to the financial viability of the organization that supports the system. The second, and more fundamentally important level, is the sustainability of the system's activities. The public-private partnership model offers an opportunity to bring diverse groups together to support the system.

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[*] From the Planning Board 2015 report "Strengthening Patient Care: Building an Effective National Medical Device Surveillance System" Brookings Institution, Washington DC

Data governance policies play a significant role in ensuring that partners are willing to participate in the system. The data governance establishes how data is included in, accessed, and managed within the data infrastructure. These policies also need to ensure that the data within the system can be trusted, are accessible when needed, provided in a format that is usable for the intended purpose(s), are of high quality (integrity), and are secure. The Planning Board's 2015 report outlined the following criteria which are intended to guide the development of the data governance policies, and the procedures used to implement them.

PROTECTING PATIENT PRIVACY

Many parts of the data infrastructure, particularly the source data systems, will include patient information. The data governance policies should meet the legal and regulatory patient protections. The HIPAA Privacy Rule establishes provisions for the protection of protected health information and appropriate permitted disclosure of information for certain purposes. The Privacy Rule allows covered entities to disclose protected health information to public health authorities for designated public health purposes. The Planning Board anticipates that some NEST activities conducted for FDA will fall under this provision. For example, surveillance analyses of drugs performed for FDA by the Sentinel Initiative are not considered research and fall under this provision.[58] However, other efforts such as postmarket evidence generation activities to support device evaluation for other regulatory decision- making must comply with both the Common Rule and the Privacy Rule.

The Planning Board anticipates that the data infrastructure and other tools developed for the NEST collaboration may also be valuable for other secondary applications beyond device surveillance. However, use of the data for these purposes would need to comply with the regulations protecting patients and their privacy including HIPAA and the Common Rule. For example, under the Common Rule, to the extent that the data involves identifiable private information, evidence development activities would likely require an IRB approval and informed consent or IRB waiver of consent. However, it is possible that some of these activities may qualify for expedited review and waivers.[59]

Given the need to manage the different requirements based upon these two types of uses of the NEST data and infrastructure, the Planning Board believes that two different sets of policies and procedures will likely be needed. The first would be for benefit and risk assessments conducted for FDA (or another public health agency like the CDC) for active safety surveillance and regulatory decision-making. The second would be for any activities conducted for non-FDA sponsors seeking to access the data infrastructure for analytic purposes.

BUILDING DATA INTEGRITY AND SECURITY

For the system to be a valuable source of information, stakeholders must have confidence in the integrity of the data and the security of the data infrastructure. Data governance policies should address the reliability of contributed data, as well as the security of the processes used to transfer, store, and retrieve data in the virtual data infrastructure.

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* From the Planning Board 2015 report "Strengthening Patient Care: Building an Effective National Medical Device Surveillance System" Brookings Institution, Washington DC

MANAGING PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY

The system may also have access to proprietary information from stakeholders in the healthcare industry. For stakeholders to contribute data, they must trust that their data will be appropriately used and protected. To address concerns about inappropriate access and use of stakeholder information, there must be policies for addressing how to manage proprietary information and protect the intellectual property of the contributing stakeholder.

BALANCING TRANSPARENCY AND CONFIDENTIALITY

There should be a clear set of policies about when and how information generated by the system should be made publicly available. Determining what information should and should not be made publicly available, and when, is a difficult task. For example, a safety "signal" often does not translate into a true safety problem. Once a signal is identified as a potential concern, further investigation and validation is needed through more extensive data analysis. As with Sentinel, CDRH may access other data sources to corroborate a safety signal and subsequently take, and communicate, an appropriate course of action. NEST's work should be focused on supporting these analyses. Additionally, once an analysis is completed—whether it be negative, positive, or non-definitive—there must be guidelines in place for communication of the methods and results of the analysis to stakeholders.

Policies and procedures for dissemination of findings will be established by the Governing Board, and should include stakeholder input and public comment. These policies should include guidance about what findings should be made publicly available and when, and how they support the FDA's regulatory responsibilities, and different types of uses of the data. For example, results from safety surveillance or postmarket studies may have significant public health implications, and should generally be made public, including the methodology used to derive those results, whereas results from an independent study may contain proprietary or confidential information that is not of imminent concern to the public's health. The information made available to the public should be meaningful and understandable. Policies should also describe how potential conflicts of interest are addressed and disclosed.

APPENDIX D: PLANNING BOARD DISCLOSURES

Planning Board members were selected to represent various stakeholder interests, as well as for their involvement in the medical device evaluation ecosystem. As such, some members and/or their organizations have directed and/or been involved in some of the projects referenced in this report.

Elise Sweeney Anthony
- Ms. Anthony is the Director of Policy at ONC. Ms. Anthony's work at ONC includes, among other things, activities related to interoperability, unique device identifiers, data segmentation for privacy, the ONC Health IT Certification Program, Sync for Science, the Precision Medicine Initiative, the Health IT Policy Committee, and the Health IT Standards Committee.

Kathleen Blake
- Dr. Blake serves as Co-Chair of the Health Information Technology Policy Committee of the US Department of Health and Human Services and is a member of the multi-stakeholder Learning UDI Steering Committee convened by the American Hospital Association.

Mark Deem
- Mr. Deem has nothing to disclose.

Nancy Dreyer
- Dr. Dreyer leads a large team of scientists who actively conduct research on the safety and effectiveness of medical devices across a broad portfolio.

Joseph Drozda
- Dr. Drozda was the principle investigator for several of the projects mentioned in the report: the Mercy UDI project, the BUILD Initiative, and ASTER-D.
- Dr. Drozda has also been an advisor to the RAPID project.
- Dr. Drozda was both contributor to the Brookings UDI roadmap and part of the UDI Implementation Work Group.
- Dr. Drozda contributed to the PEW UDI roadmap.
- Dr. Drozda is on the stakeholder panel of the PCORI funded UDI2Claims Project (Joel Weissman, PI).

Barbara Evans
- Dr. Evans has received academic research funding from various sources (The Greenwall Foundation, NIH/NHGRI, The Robert Wood Johnson Foundation, The University of Houston Law Foundation) to study privacy, governance, regulatory, and financing issues around large-scale data commons for diverse public health, research, treatment, and regulatory science applications. Her previous work on patient-centered data commons, mentioned in this report, was funded by the Robert Wood Johnson Foundation as part of the Health Data Exploration Project (Kevin Patrick, M.D., P.I.).
- Dr. Evans has served on the Privacy Panel for FDA's Mini-Sentinel/Sentinel drug safety systems since 2010, with funding from FDA via subcontract with Harvard Pilgrim Healthcare Institute.

- Dr. Evans is a member of the National Committee and Vital Health Statistics which advises HHS on issues related to the HIPAA Privacy Rule and data access.
- Dr. Evans serves as a member of the Advisory Board for Interpreta, Inc., a private-sector data analytics company involved with healthcare delivery/payment applications not related to the medical device safety applications discussed in this report.

Rachael Fleurence
- Dr. Fleurence is the program director of PCORnet, an initiative of the Patient Centered Outcomes Research Institute.

David Flum
- Dr. Flum is a member of the PCORI Methodology Committee.

Jo Carol Hiatt
- Dr. Hiatt has nothing to disclose.

Elisabeth Kato
- Dr. Kato has nothing to disclose.

Leslie Kelly Hall
- Ms. Kelly Hall was a contributor to the Brookings UDI roadmap.
- Ms. Kelly Hall contributed to the PEW UDI roadmap.
- Ms. Kelly Hall serves ONC Health Information Technology Standards Committee.
- Ms. Kelly Hall serves on the Learning UDI Steering Committee.

Harlan Krumholz
- Dr. Krumholz is a founder of the HUGO personal health platform.
- Dr. Krumholz leads the Yale Open Data Access Project. Johnson and Johnson funds Yale University to distribute their clinical trial data.
- Dr. Krumholz is the principal investigator of a Yale University contract to participate in the FDA's MDEpiNet. Medtronic contributes to this contract.
- Dr. Krumholz chairs a Scientific Advisory Board for United Health Care.
- Dr. Krumholz is on the Board of Governors of PCORI, which has supported PCORnet.

Michael Mack
- Dr. Mack was President of the Society of Thoracic Surgeons (STS) in 2011-2012 when the STS/ACC TVT Registry was formed.
- Dr. Mack is a member of the Board of Trustees of the American College of Cardiology (ACC) and of the National Cardiovascular Data Registry (NCDR) Management Board of the ACC whose clinical registries are involved in postmarket device surveillance.
- Dr. Mack is the principal investigator or an executive committee member of three industry sponsored trials which include clinical registries for postmarket device surveillance; he is uncompensated in these roles.

Matthew J. McMahon
- Dr. McMahon has nothing to disclose.

William Murray
- As president and CEO of the Medical Device Innovation Consortium (MDIC), Mr. Murray oversaw the development of the Patient Centered Benefit-Risk Assessment framework.
- Mr. Murray is the lead investigator for MDIC's grant to establish a Coordinating Center for NEST.

Dale Nordenberg
- Dr. Nordenberg is the executive director of the Medical Device Innovation, Safety and Security Consortium (MDISS) and is co-leading the development of the National Health Technology Cyber Surveillance and Safety Network
- Dr. Nordenberg is the co-chair of the Medical Device Security Information Sharing Council of the National Health Information Sharing and Analysis Center's (NH-ISAC)
- Dr. Nordenberg is a member of the ONC HIT Standards Federal Advisory Committee.

J. Marc Overhage
- Dr. Overhage was part of the UDI Implementation Work Group for the Brookings UDI roadmap.

Gregory Pappas
- Dr. Pappas is a co-chair of the Scientific Oversight Committee of MDEpiNet.

Edmund Pezalla
- Dr. Pezalla has nothing to disclose.

Ken Reali
- Mr. Reali has nothing to disclose.

Alan Rosenberg
- Dr. Rosenberg was both contributor to the Brookings UDI roadmap and part of the UDI Implementation Work Group.
- Dr. Rosenberg is Vice President for Anthem, Inc. and provides input to Anthem in its governing body votes on UDI incorporation into claim sets.

Patricia Shrader
- Medtronic, Inc. has been or is involved in multiple projects mentioned in this report, including the BUILD Initiative, MDEpiNet, the MDIC Patient Centered Benefit-Risk Assessment framework, the Mercy UDI pilot, the Brookings and PEW UDI roadmaps, PCORnet, the TVT registry, and the Sentinel System. However, Ms. Shrader is not directly involved with any of these projects.

Tamara Syrek Jensen
- CMS allows the use of registry data for quality reporting, however Ms. Syrek Jensen is not directly involved with that work.

Carol Walton
- Ms. Walton has nothing to disclose.

Natalia Wilson
- Dr. Wilson was both contributor to the Brookings UDI roadmap and part of the UDI Implementation Work Group.
- Dr. Wilson is an investigator for the BUILD Initiative.

Duke-Margolis faculty and staff
- Duke-Margolis has multiple cooperative agreements with FDA, which include convening stakeholders to explore multiple medical policy issues, such as the development and implementation of the Sentinel System.
- Dr. McClellan, Dr. Daniel, and Mr. Bryan are authors of the Brookings UDI roadmap.
- Dr. Daniel contributed to the PEW UDI roadmap.
- Duke University investigators are leading MDEpiNet's PASSION projects RAPID and SAFE-STEMI, and led the Duke University Health System's Automated Adverse Drug Event Detection and Intervention project. However, no Duke-Margolis staff involved with this report have had any direct involvement in those projects.

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