U.S. Department of Health and Human Services
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ISSUE BRIEF

Maximizing Data Interoperability and Integration to Support Value-Based Care

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Introduction

Public and private payer initiatives are reforming health care by providing incentives to deliver higher quality and lower cost care through value-based care models. For providers to be successful in these payment models, which hold them accountable for the health of the population they serve, interoperability of electronic health data is essential to coordinate and monitor their patients' care. This is particularly important for complex patients who frequently access the health care system across multiple settings. Though there has been progress in the adoption of health information technologies that serve as the foundation of information exchange and there is increasing evidence of data sharing in terms of the ability to send, receive and find data from multiple outside sources, more progress is needed to achieve consistent and necessary data integration across the care spectrum. This brief describes the current state of data integration, or the extent to which data are available within a workflow to support the insight needed for patient care, analytics, and reporting without additional effort by the user. Within this context, the brief identifies technological, organizational and environmental facilitators of and barriers to integrating data exchanged between trading partners into workflows.

Highlights

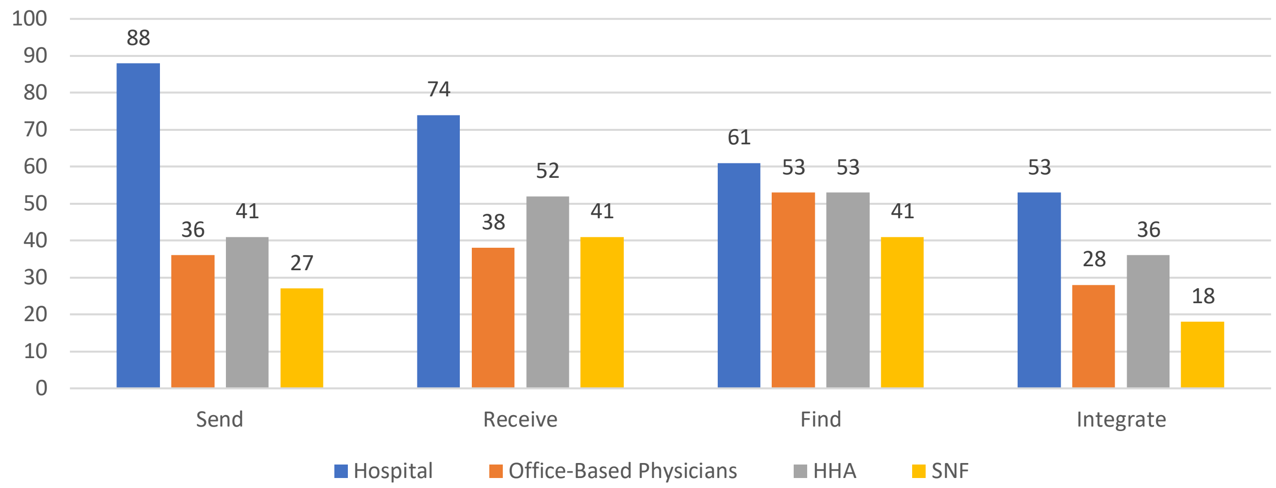
- Though easy access to patient data from outside sources is essential for care coordination, quality measurement and population health management, the ability to integrate outside data into a workflow in a format that allows the user to draw needed insights from the data without additional effort remains limited.

- There are different levels of data integration reflecting a continuum of both availability of data and their value within workflows at various points.

- Integrating data from outside sources such as provider notes, diagnostic imaging, ADT alerts, discharge summaries and care plans could help support key care coordination activities that providers currently report limited ability to perform.

- A key gap includes limited research documenting what data integration currently looks like on the ground. Additionally, although a host of technological, organizational, and environmental factors may facilitate or impede data integration (Figure 3) little is known about what those specific factors might actually be. These could include the heterogeneity/similarity in HIT products implemented by individual trading partners, the prevalence of value-based models in a region, concentration of ownership, and active Health Information Organizations (HIOs)

Figure 1. Reported Engagement or Capacity to Engage in Interoperable Exchange by Setting, 2017 (%)



Synthesized from ONC Data Briefs 41, 42, and 47 based on data presented from:
Hospitals: 2017 AHA Annual Survey Information Technology Supplement;
Office-based physicians: 2017 National Electronic Health Record Survey; and
Home Health Agencies (HHA) and Skilled Nursing Facilities (SNF): 2017 IQVIA Nursing Home and Home Health Agency Census

The Current State of Data Integration

As depicted in Figure 1, although data exchange is becoming more commonplace, particularly in hospital settings, once exchanged, the ability to integrate data into care processes and analytics lags across all settings.

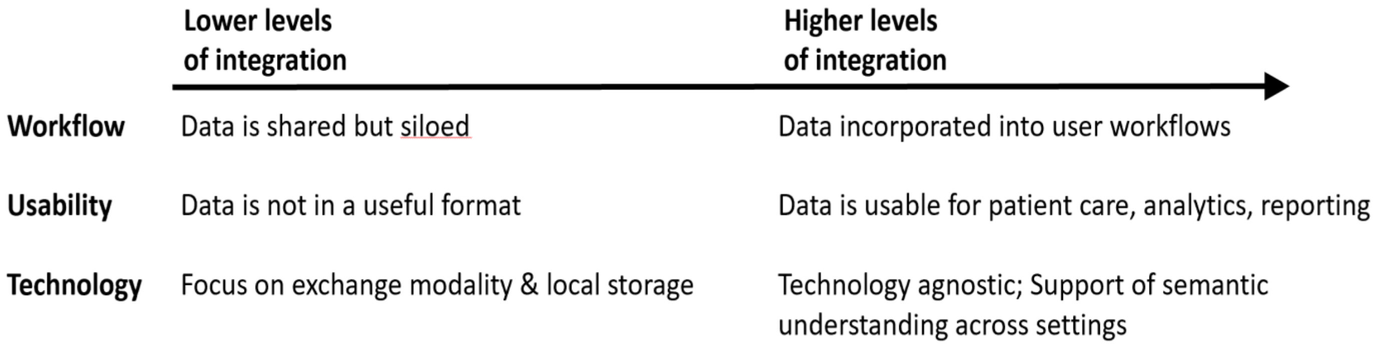
- Although more than half of hospitals reported integrating some health information received from outside sources in 2017, data integration was less common across other settings with which hospitals must share accountability for patients.

- Only 28 percent of office-based physicians, 36 percent of home health agencies, and 18 percent of skilled nursing facilities reported integrating outside data into their systems.

To achieve the goals of value-based care, providers need easy access to various data to identify high risk patients and to coordinate care across settings, but little is known about whether the type of data being integrated is useful for risk stratification and care coordination, and whether it is being used.

- Early studies have found low usage of data from outside sources among providers (1, 2), suggesting low usability and limited availability of current data integration tools. Among the reasons that hospitals identified for this low usage are difficulties in integrating the information in the EHR, information not available when needed, the format of presentation, difficulty in finding information within the EHR, and the information not being integrated into the workflow (3).

- In addition, a recent survey found US primary care physicians reported more limited ability to coordinate care with specialists and with social service providers than their counterparts in



	Lower levels of integration	Higher levels of integration
Workflow	Data is shared but siloed	Data incorporated into user workflows
Usability	Data is not in a useful format	Data is usable for patient care, analytics, reporting
Technology	Focus on exchange modality & local storage	Technology agnostic; Support of semantic understanding across settings

other high-income countries (4). The ability to automatically or easily integrate well-established standards-based data, including admission discharge transfer (ADT) information, clinical notes including discharge summaries, care plans, laboratory and other test results, and so-called PAMI information (problems, allergies, medication and immunization) information would increase providers' ability to fully understand patient needs and to coordinate care.

Rather than thinking of data integration as occurring or not occurring, it is important to recognize there are different levels of data integration (Figure 2). Higher levels of integration enable end users to more easily access and use data as part of their workflow.

There is scant literature on the extent to which data is being integrated to support specific care processes and the methods used to integrate the data; instead, much of the literature focuses on assessing the benefits of interoperability on various outcomes. Studies on the impact of interoperability have examined outcome metrics such as healthcare costs, utilization, and quality, while providing limited insight into data integration processes such as medication reconciliation, updating problem lists, and other care coordination activities (5).

However, data integration at higher levels is needed to fully realize the potential benefits of health information exchange. A broad range of technological, organizational and environmental factors affect the integration of data exchanged between trading partners.

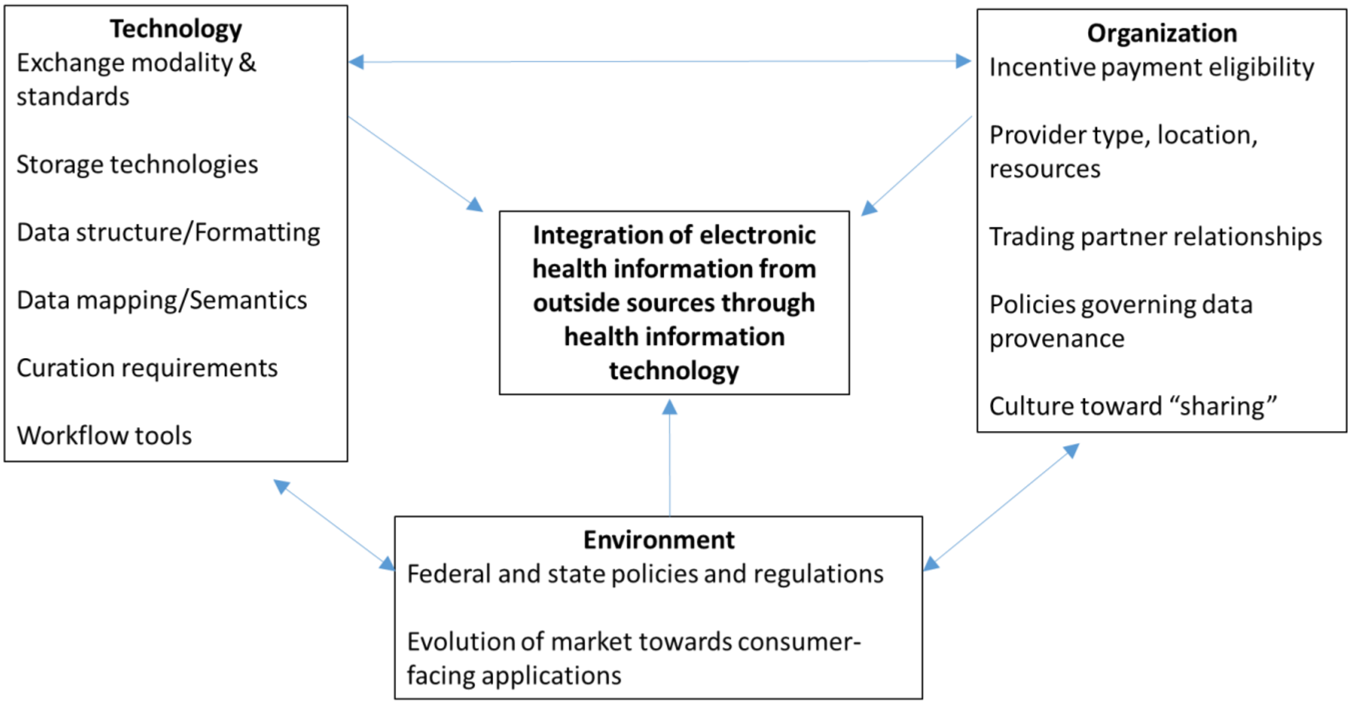
- Given the broad range of factors affecting the integration of electronic health information from outside sources, this brief uses the Technology-Organizational-Environment (TOE) conceptual framework (6). This framework, from the diffusion of innovation literature, has been used in other research on health information exchange and suggests the adoption of innovations depends on technological, organizational, and environmental factors (see Figure 3).

Technical Factors

Eventually, where data is stored and how it is exchanged will not matter because policy and technological approaches to data integration are moving towards a variety of workflow tools that facilitate access to the right information at the right time. However, in its current state a number of technical factors and barriers affect data integration, which are the focus of this section.

Currently, depending on the method of exchange, the share of hospitals that are routinely sending and receiving summary of care documents varies, as do the facilitators and barriers to discrete data integration (see Table 1).

- As a baseline regardless of the method of exchange, data integration within a 2015 CEHRT product should include the ability to parse discrete data regarding Problem List



Source: Based on framework presented in DePietro, Wiarda & Fleischer, 1990

diagnoses, Allergies, Medications, and Immunizations (PAMI information).

- Direct Secure Messaging (DSM) is the most common third-party method of sharing data. More than 250 million messages were transmitted during the three months ending 6/30/19 (7). The most frequent use cases for DSM are transitions in care, referrals and public health reporting. Data integration, if it is attempted, should include PAMI. Other data or data integrated into a non-2015 CEHRT product exchanged through DSM is likely to be formatted as a machine searchable CCD and/or a human readable image of the CCD

- Health information organization (HIO) services are widespread. The Strategic Health Information Exchange Collaborative (SHIEC) estimates that its nearly 80 members offer services in regions that cover 92% of the U.S. population (8). Though HIOs provide geographic breadth, the heterogeneity of certified health IT products, the cost and inconsistent implementation of interfaces, and inconsistent adherence to standards are among key barriers to data integration when exchanging data via HIOs. Given the competing methods of exchange, HIOs are increasingly focused on high value use cases and value-added services such as ADT alerts and registry reporting, which require data integration.

Wide-scale data integration is most likely to occur between providers within a single EHR vendor network. For example, Epic's Care Everywhere network reports approximately 150 million clinical documents transferred between its customers per month (9). Data integration is simplified within a single vendor's system and there is evidence of a significant rate of use of external data within this context.

- eHealth Exchange has introduced hub interconnection services to supplement its point-to-point offerings in order to support broad exchange between participating trading partners and across regions. A hub solution makes exchange more cost effective, simplifies technology requirements, supports standardization, and potentially connects to a broader range of exchange partners. This should enhance the implementation of data sharing requirements under the Final Rules of the 21st Century Act.

- National cooperative solutions including the eHealth Exchange, Epic Care Everywhere, and CommonWell Health Alliance networks, and the Carequality framework which allows these networks to interconnect, are actively addressing data exchange and integration barriers. These activities parallel development of the federal Trusted Exchange Framework and Common Agreement (TEFCA) initiative which is being developed in collaboration with Carequality.

- Data that is currently being exchanged vary in adherence to established standards, and thus may be displayed or integrated in ways that are more or less accessible to or useful for providers. Issues with data and document exchange standards (C-CDA) that create barriers to data integration into workflows have been identified, particularly conformance to certification standards.

- Interfaces are a specific problem with the large number of certified health IT products in use. The variability and inconsistency in implementation can result in incongruent or misaligned standards. Additional barriers include the cost of implementing and maintaining point-to-point interfaces and upgrade costs required to support data exchange.
- Vendor implementation of the standards and services that support interoperability have been inconsistent, resulting in data quality concerns due to incompleteness of exchanged data, inconsistent codification, and resultant poor usability. Newer versions of standards and more stringent certification requirements are addressing these issues. However, concerns remain about adherence to standards of data content and syntax, both of which are critical to data mapping and usability within a workflow (10).
- A related barrier is semantic interoperability, or the use of common vocabularies and data mapping which is required for valid and reliable integration. Research indicates that while improvements have occurred, key issues remain in four domains: variability of data entry/capture in source systems, empty or null data fields, variation of information within a data element, variation in information location across domains and vendors, and inconsistency in terminology use (11).

- Exchanged CCD-A documents, particularly the Consolidated Clinical Document (CCD), are often lengthy, cumbersome, difficult to search/browse, lacking effective indexing functions and difficult to parse. The documents typically contain a substantial portion of unstructured data which create numerous constraints on their use. These documents often take substantial computational power to process and ultimately may not contain the information that the provider seeks. Thus, even when technical exchange is successful and data available in the EHR, providers may not integrate the data into the care process because of workflow and usability issues.

- The exchange of C-CDA documents demands significant and ongoing storage capacity at both the sending and receiving organization. This is developing as a significant cost of interoperability as participation in and volume of document exchange increases.

Application Programming Interfaces (APIs) provide a parallel solution to document exchange that may simplify discrete data integration. APIs can be based upon open or proprietary standards.

- APIs present a well-established solution to the integration of data from heterogeneous sources and are widely used to support interoperability and transactions across the Internet in various industries. ONC has supported the development of standards for using APIs to access and exchange health information (12).

- Provider to provider connections through APIs allow for efficient data exchange and integration. Solutions can be either Fast Healthcare Interoperability Resources (FHIR®)-based or can use proprietary standards.

Table 1: Factors Affecting Data Integration in Technology-Organizational-Environment Framework

Exchange Modality Using a Third Party	Hospitals Routinely Receiving Summary of Care Records (%)	Hospitals Routinely Sending Summary of Care Records (%)	Key Data Integration Facilitators	Key Data Integration Barriers
HISP (e.g., Direct Secure Messaging)	49%	68%	Ubiquity based on Meaningful Use requirement, Provider Directory, EHR integration	Patient matching, manual vs. auto-linking messages to patient record, manual vs. auto-routing to appropriate recipient, usability of received documents/data, clinical workflow integration
State, regional, or local HIO	43	55	Regional coverage, state agency integration, stakeholder engagement, Patient-Centered Data Home	Interface technical & cost challenges, business model sustainability, variety of EHRs in use, technical & semantic interoperability, complexity & costs of achieving interoperability, variable functionality and services across regions
Single EHR vendor network	37	42	Rules of the Road/governance, data native to the system, patient matching, machine readable parsing, encounter level documents/data, workflow integration	Variable functionality when connecting with exchange partners using other vendor products, proprietary standards
eHealth Exchange	23	29	Data use agreement, federal agency connection, national footprint, new hub services, use of Carequality framework	Interoperability challenges, challenges of document-based exchange, does not provide comprehensive regional coverage
Multi-EHR Vendor Network (e.g., CommonWell)	22	24	Rules of the Road framework, open to all vendors, data use agreement, vendor to vendor solution reduces need for intermediaries and interfaces	Variability in structure of C-CDA documents, patient matching, number of participating organizations

Source for percent of hospitals receiving and sending summary of care records using each modality: Johnson, C., Pylypchuk Y. & Patel V. (December, 2018). Methods Used to Enable Interoperability among U.S. Non-Federal Acute Care Hospitals in 2017, no. 43. Office of the National Coordinator for Health Information Technology: Washington, DC.

- HL-7's FHIR is quickly advancing as the standard for API implementations in healthcare. FHIR focuses on granular/modular components, or resources, that can be used as building blocks in the assembly of clinical or administrative data packages tailored to specific use cases. FHIR leverages existing web architectures and security standards to enable rapid implementation and to support a wide variety of exchange types. FHIR allows specific clinical data elements to be shared rather than requiring the exchange of C-CDA documents, potentially simplifying data integration (13).

- Though it can facilitate data integration, FHIR is not currently implemented consistently or accurately across HIT systems; certified health IT developers may use different versions of FHIR, and implementation of FHIR resources can vary between developers using the same version (14).

Barriers to data integration include incorporating structured and unstructured data into the recipient EHR, requirements for data segregation, and user interfaces that may complicate workflow.

- The types of data needed for care coordination also complicate integration. These include unstructured data, including free-text notes, which present specific challenges for data integration when exchanged. Other data types that present technical integration challenges include those covered under 42 CFR Part 2 which require specialized segregation and role-based access within the EHR receiving that information. Alternatively, a patient record excluding that information could be exchanged, though this raises potential patient safety issues related to incomplete information. In either case, technical barriers may exist at the EHR or HIO level.

- User interfaces can complicate workflow and create barriers to data integration and ease of access to data from outside sources, impacting their use. A recent study indicates that user interface designs that comingle local and outside data result in higher levels of viewing compared to when the data are presented separately (15).

Organizational Factors

Organizational factors that facilitate or complicate data integration include incentive payment eligibility, provider type, trading partner relationships, location, resources, and policies governing data provenance.

- There are two principal use cases for integrated data within an organization:
    - Point of Care Uses
    - Reporting and Analytics

- The role of the provider (medical assistant, nurse, doctor, administrative staff) in the clinic workflow can vary significantly based on their specialty. Therefore, the role of the provider can vary significantly from care setting to care setting, which has made widespread integration and training difficult. Lack of clarity in this area can lead to technical integration issues because it is difficult to know how to build functionality to enable use of the data.

- Many trading partners critical to value-based care were not included under the Meaningful Use / Promoting Interoperability program and consequently lack CEHRT products. This includes long-term and post-acute care, behavioral health, and many medical specialties, including pediatrics. Most of these providers do not use technologies capable of supporting the standards required for exchange (16,17). Use-case driven solutions, such as dedicated ADT notification systems, are evolving, but overall data integration is lacking.

- The affiliations and reimbursement models for providers and other trading partners may determine the technical characteristics of the data exchanged and reporting requirements. This can drive the characteristics of HIT systems. For example, providers in accountable care organizations (ACOs) or other value-based partnerships have greater incentive to develop effective infrastructures for data exchange, including to the ability to integrate data to promote care coordination.

- Available financial resources substantially affect an organization's ability to access, exchange, use and integrate data. Critical access, rural and small hospitals trail other types of non-federal acute care hospitals in all interoperability measures (18). This may owe to their inability to participate in a vendor network or regional and national initiatives. Smaller and/or rural ambulatory providers are also less likely to belong to hospital networks. An additional resource constraint may be the availability of technical staff to support interoperable services.

- Organizational governance policies related to data provenance are important to data integration. Organizations' policies regarding integration and usage of outside data are the ultimate factor in determining data integration. Data provenance concerns are centered in three areas: (1) medical liability associated with treatment based upon the integrated data (2) medical liability associated with having external data available that is not accessed or used because the provider does not access it and (3) the quality and reliability of the data originating from the outside source. Research indicates that among office based-physicians receiving patient health information from an outside source, very few reported not trusting the information as a reason for not using the information (19). Proposed US Core Data for Interoperability (USCDI) data standards address data provenance by requiring stamps for the author of the data, a time stamp, and the name of the author's organization.

- A factor that is somewhat amorphous is the issue of the organizational culture and attitudes toward data-sharing. This can encompass competitive concerns, trust in trading-partners, and approaches to training. For example, the same data can be provided to two different organizations but used in two very different ways.

- There appears to be no general view on how much data is the "right" amount to exchange, and too little or too much data are both not considered useful. The preferred amount of data to be integrated may vary by organization and by roles within an organization.

Environmental Factors

Public policies and regulations are fostering an environment that promotes data integration.

- The movement to value-based care is increasing both the utility of patient data from outside sources and the value proposition for care coordination and population health management. This can significantly reduce real or perceived competition between providers within a region, which has historically been a barrier to data exchange.

- The Promoting Interoperability program has supported interoperability since its inception. Specifically, attestation to the measure "Support Electronic Referral Loops by Receiving and Incorporating Health Information" incentivizes the exchange and integration of discrete clinical data. Similar to other Promoting Interoperability measures, this is a binary measure made in a lab setting and may have conformance issues in practice, or providers may not have the technology to support this use-case.

- The Trusted Exchange Framework and Common Agreement (TEFCA) will establish principals, terms and conditions to enable exchange across networks. TEFCA is being designed to scale Electronic Health Information (EHI) exchange nationwide and to help ensure that health information networks, health care providers, health plans, individuals, and other identified stakeholders have secure access to their electronic health information when and where it is needed (20). By establishing the rules of the road and requirements related to standards and interoperability through the oversight of the Recognized Coordinating Entity (RCE), greater data liquidity will be supported.

- The proposed U.S. Core Data for Interoperability and Expansion Plan lays out a standardized and evolving set of health data classes and constituent data elements required for nationwide, interoperable health information exchange (21). This specification will enhance data exchange and integration. The specificity of the data included in USCDI maps to specific FHIR Resources, which will also facilitate the use of APIs. This facilitation will be enhanced by USCDI's data provenance requirements.

Consumer-facing applications provide a potential efficient and low-cost facilitator of data exchange and integration.

- As an evolving option, consumer-mediated exchange through individuals' access to their own health data and consumer-facing applications could significantly change how these data are accessed, integrated and shared. This approach uses third parties to aggregate and manage health data and allows consumers to manage data transfer and other sharing activities.

- There are more than 316,000 health-related mobile apps, and more than 60 percent of smart phone users have downloaded a wellness or medical health app (22).

- High profile initiatives, including those from leading technology companies, have been established that support the aggregation and exchange of consumer data that have the potential to be more easily integrated than solutions provided through traditional health information exchange modalities. This approach is enhanced by public policies requiring that certified health IT products support data access via APIs by 3rd party applications.

- While patient portals as a means of individual access to data have had substantial success in some cases, usage has been flat. Approximately 52% of patients have been offered access to a portal. Of those offered access, in 2018, 30% of patients accessed their records through the portal at least once during the year. (23). Some of these portals are being repositioned as aggregators to support consumer-mediated exchange. For example, Epic's MyChart allows patients to aggregate their records across different providers using Epic's portal solution.

Summary

Stakeholders broadly recognize the imperative of accessing, exchanging, integrating and using data from across the care spectrum to achieve the goals of value-based care. Though there is increasing evidence data exchange is occurring, less is known about how data are being integrated into workflows and used across the care spectrum.

- The ability to exchange data, defined as sending, receiving, and finding data, has reached a critical mass across care settings, ranging from 88 percent of hospitals to 53 percent of skilled nursing facilities. However, data integration into the recipient system is far less common, ranging from 53 percent of hospitals to 18 percent of skilled nursing facilities.

- US primary care providers have reported limited ability to perform a number of key care coordination activities that could be facilitated by integration of data from outside sources such as ADT information and clinical notes, including discharge summaries, care plans and diagnostic imaging reports.

- The data integration currently occurring varies in the level of data accessibility and usability for providers, ranging from scanned documents that are difficult to search, to specific data elements that comingle and display automatically in the local EHR. The data format, the degree to which it conforms to existing standards, and user interface design all affect the level and utility of data integration.

- Some evidence demonstrates the impact of data exchange on improving the cost and quality of care. However, more frequent data integration at higher levels is likely needed for these benefits to be fully realized as patient data from outside sources can be more seamlessly used at the point of care, for quality measurement and for population health management.

- Technical factors play a substantial role as both facilitators of and barriers to integrating data

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Table 2: Summary of Facilitators and Barriers to Data Integration

Domain	Facilitators	Barriers
Technical	• CEHRT Products • Exchange modality alternatives: (e.g., Vendor, eHEx) • Template-Based Standards • Standard-based APIs (e.g., FHIR) USCDI •	• HL7 Interface Costs/Upgrades • Inconsistent Standard Implementation and proprietary standards • Data-Mapping • Variance in Trading Partner Capabilities • Structured/Unstructured Data • Proprietary standards including some APIs • Difficulty implementing data segmentation requirements to address 42 CFR Part 2
Organizational	• Participant in Value-Based Care (VBC) and/or other programs that incentivize or require sharing of health information Promoting	• Workflow • Data Governance (Data Provenance) • Limited Financial/Staffing Resources
Environmental	• TEFCA • User demand to have EHR data in apps (whether patient facing, provider facing, etc.) and for that to be directional (e.g., PGHD).	• Information-blocking • Support for non-CEHRT providers • Complexity of Care Continuum

from outside sources. A key factor is the method of exchange, particularly the specific exchange modality, such as the use of a regional HIO, national networks, or a single vendor solution. The increasing growth of national cooperative solutions will likely address these problems. Technical barriers and facilitators also include the characteristics of exchange (C-CDA documents or data elements via APIs) and whether products are certified to the latest (currently 2015) ONC standard.

- Organizational factors that impact data integration include whether an organization is eligible for the Promoting Interoperability program, whether a provider participates in a value-based partnership or ACO, and the organization’s financial resources, priorities and leadership engagement. An organization’s data governance policies concerning data provenance can also determine how data from outside entities are used. These issues concern both potential medical liability and data quality.

- A principal environmental factor driving data integration is the movement to value-based care, which can act as a major facilitator to data exchange and integration. This movement also reduces real or perceived competition within a region. Public policies supporting data exchange include requirements under Promoting Interoperability and proposed rules under ONC (TEFCA and USCDI) and CMS.

Overall, there is little research specifically documenting what data integration currently looks like on the ground, or on specific facilitators and barriers. Further research on this topic is needed to inform efforts to increase integration of the data needed to support the goals of value-based care.

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