Chapter 10
Workflow at the Edges of Care

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10.1 Introduction

In order to understand specific tension points related to workflow capture and measurement, one might revisit the turn of the last century. Here, two landmark reports highlighted gaps related to care quality and safety in the United States' healthcare system. First was the Institute of Medicine (IOM) report *To Err Is Human: Building a Safer Health System*. Written by the IOM Committee on Quality Health Care in America, this report emphasized that errors resulting in patient harm are properties of healthcare systems, not just the health professionals in the systems. It follows that patient safety is also a property of systems of care. Errors refer to "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim" (Donaldson et al. 2000). Errors that cause injury or harm lead to preventable adverse events.

Shortly afterwards, the National Academies of Medicine released their landmark report, *Crossing the Quality Chasm: A New Health System for the 21st Century* (Baker 2001). This report attributes rapid technological development, the growing complexity of healthcare, and fragmentation of care delivery as factors contributing to a healthcare system unable provide safe and high-quality care to all individuals in the system.

The care fragmentation described in the report disproportionately impacts high-need populations, including those with multiple or complex chronic health issues who experience frequent changes in health status and multiple transitions between care settings and providers, as well as patients at risk for multiple social and behavioral determinants of health. Workflow modeling can improve the integrity of the

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K. Zheng et al. (eds.), *Cognitive Informatics*, Health Informatics,
https://doi.org/10.1007/978-3-030-16916-9_10

healthcare safety net, which currently exists as a loosely connected patchwork of safety net services, meant to support these individuals. Understanding workflow at the edges of care can prevent patients "falling through the gaps," lead to improvements in the overall quality of care and even suggest novel technological development in line with healthcare system and patient work.

The IOM committee provided ten general principles to inform care redesign efforts and mitigate errors. One of these principles emphasized improved collaboration and cooperation between clinicians and care institutions to promote information exchange and care coordination. Information exchange and care coordination between care systems, providers, and patients and their families are critical targets for workflow study at the edges of care.

Workflow measurement is largely linked to general quality improvement efforts in electronic health record (EHR) usage. In 2009, the Medicaid and Medicare EHR Incentive Program was established under the Health Information Technology for Economic and Clinical Health (HITECH) Act. This program helps support patient engagement with their personal health records. This has increasingly directed attention towards consumer health informatics (CHI) such as mHealth and easily accessible tools (such as blood pressure cuffs or pedometers) (Blumenthal and Tavenner 2010). During this time, Affordable Care Act (ACA) also incentivized the creation of accountable care organizations (ACOs) and formalized partnerships between social services and community-based organizations to improve the quality of transitions and post-hospital care (Nasarwanji et al. 2015).

10.2 Current State of Workflow Mapping at the Edges of Care

10.2.1 Transitional Care

According to the Centers for Medicare and Medicaid Services, a transition of care occurs any time a patient is transferred from one care setting to another (Mansukhani et al. 2015). These settings include primary care offices, specialists, pharmacies, home care agencies, acute care hospitals, emergency departments, in addition to social service institutions and the patients' own homes. Care transitions, sometimes called "handoffs," are vulnerable points in the care process. They possess a few types of **inherent error vulnerability** (complexity, communication breakdowns, and shifting responsibilities of care) which operate synergistically to contribute to errors (Cortelyou-Ward et al. 2012). In an example where a patient transitions out of a hospital to home care, those error vulnerabilities may manifest in the following ways:

– *Complexity*: Even with rapid consolidation of smaller practices and care systems, transitions often happen between high numbers of small, independent providers. They may include several members of a care team and involve the exchange of a

large amount of information. A patient may interact with multiple providers and staff and be given significant, complex instructions and education for their post-discharge care. Changes to medication regimens also contribute to complexity during care transitions.
- *Communication breakdowns:* The transfer of patient information (i.e., charts, images, test results) between levels and locations of care helps to ensure care continuity. However, breakdowns of these processes and discontinuous information transfer between care teams and care settings lead to poor care transitions. Common issues include: information not sent from the primary care setting to the specialist (and vice versa), key information missing from EHRs, information included in EHRs but still insufficient for providers, unavailability of test results, a lack of follow-up arrangements made, and poor communication of discharge summaries between patients and providers. Most of these issues occur between different types of providers, patients and their families, hospitals, and other care settings.
- *Shifting responsibilities of care:* A patient's self-care responsibilities may markedly increase when transitioning from complete care by a hospital team to individual or assisted care at home or at a transitional care facility.

Together, these factors make care transitions vulnerable exchange points that contribute to high rates of health services use and spending (Kripalani et al. 2007). Error vulnerability leads to a higher relative incidence of systemic errors, adverse clinical events, healthcare waste, and prevents patients' care needs from being sufficiently met (Naylor et al. 2011; Coleman et al. 2005). Barriers to addressing these issues include overstressed primary care systems with large and diverse patient panels and tasks as well as an overall lack of integrated care systems (Bodenheimer 2008). Studying workflow across transitions in care, care teams, and care settings should be a high priority if we are to improve care quality and patient safety.

10.2.2 Care Coordination in Transitional Care

Workflows associated with **care coordination** across the healthcare continuum are high-yield opportunities to improve patient care. Care coordination can be broadly defined as the "deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of healthcare services" (McDonald et al. 2007). Care coordination considers all resources, including personnel and information, required to carry out all required patient care activities. Improving care transitions and collaborative care of patients across settings requires the integration of care delivery processes across settings (Mansukhani et al. 2015). Meaningful metrics of care coordination that can be targets of workflow optimization include:

- provider, interorganizational, and interagency collaboration and communication
- meaningful use of health information technology (HIT)
- medication reconciliation

– discharge processes (ensuring access to care after discharge, communication of healthcare information during discharge)
– post-discharge follow-up (follow-up phone calls, post-discharge home visits)

At the edges of care, healthcare personnel must consider not only organization-wide, but also system-wide workflow. There is an increasing push to capture and crystallize processes occurring at these "edges" and map the workflow between these edges when possible. One result of these efforts to decrease fragmentation in transitional care focuses on reducing hospital readmission rates, a key metric tied to insurance reimbursement (Naylor et al. 2011). Common methods to study workflow in transitional care include multi-site ethnographic observation, semi-structured interviews, and the development of process maps, flowcharts, and activity diagrams. Currently, most workflow mapping in transitional care occurs in and around acute care settings and specific programs focused on costly and complex care, such as behavioral and medical health integration.

10.2.3 Types of Workflow Study in Transitional Care Settings

Qualitative analysis in behavioral health settings: Kaiser and Karuntzos previously reported a qualitative workflow study conducted with practitioners involved in SBIRT (Screening, Brief Intervention, and Referral to Treatment), an evidence-based practice focused on alleviating substance use disorders, focused on characterizing and better integrate workflow. The study team conducted direct observations (focused on workflow processes related to care delivery, documentation, information storage and sharing, and patient engagement), semi-structured stakeholder interviews to identify workflow variation, and document reviews. The interviews resulted in the development of observation-informed standard workflows to visualize patient and information improvement across care systems (Kaiser and Karuntzos 2016).

Lean methodology to standardize transitions from intensive to ambulatory care units: A tertiary care center identified variation and unpredictability in patient transitions between intensive care units (ICUs) and ambulatory care units (ACUs) as a contributing factor to patient harm and systemic inefficiency. In order to develop standardized processes to transfer patients between ACUs and ICUs, leadership engaged key stakeholders, used lean methodology including process mapping (swim lane flowchart), analyzed waste and opportunities to standardize processes. Stakeholders together selected an "ideal state" solution using of checklists as a tool to guide workflow adherence. While this workflow study resulting in improvements in perception of communication clarity and adequacy and duration of transition, it was an intensive effort, requiring extensive time dedicated to process development and evaluation. Keeping in mind this significant resource cost, this study may be a useful guide to institutions involved in patient care transfers (Halvorson et al. 2016).

Clinician-centered continuity of care approach: Abraham and colleagues utilized observations, shadowing, audio recording, semi-structured interviews, and artifact identification and collection to explore clinician workflow before, during, and after a patient handoff. Evaluating workflow through the lens of clinician work activities allowed the identification of interdependencies between different parts of a patient handoff. Because workflow was analyzed across a full continuum of care, they also developed a non-linear descriptive framework of handoff communication (handoff as a discrete communication activity) that accounted for emergent collaboration and interactions between individuals on the care team. In mapping these workflows, the team was also able to identify specific points of information breakdown at a high level of granularity (Abraham et al. 2012).

Activity log modeling for care coordination: Another approach used internationally to study care coordination utilizes workflow activity logs, a granular (specific and detailed) data collection method. Describing and collating a large number of workflow functions across a care coordination workforce working at a specific organization dedicated to care coordination across settings can help identify gaps in local capacity for care coordination and also stimulate intentional practice redesign (Heslop et al. 2014).

10.2.4 Small and Resource-Limited Care Settings

Small or rural primary care practices, community health centers, and community-based health organizations are all examples of resource-limited care settings or care settings experiencing significant barriers to engaging in quality improvement efforts related to workflow improvement. These practices, sometimes termed "priority primary care practices," are high-priority areas for workflow and information technology optimization. Resource limitation in these settings is characterized by a lack of infrastructure, limited internal management or information technology expertise and little or no access to external expertise in these areas due to financial or geographical reasons. These smaller primary care practices, found often in densely populated urban areas with high need and rural areas, make up half of all primary care practices (Liaw et al. 2016; Wolfson et al. 2009; Ryan et al. 2013).

Workflow in small practices A report on the adoption gap of EHRs indicates that only a fraction of small physician offices has fully implemented EHR systems. Ramaiah and colleagues utilized an interpretive case study approach to evaluate factors influencing workflow automation in small primary care practices. This approach triangulated questionnaires, *in situ* work observations, and interviews to study tasks conducted from the beginning to the end of a patient's visit. Workflow was mapped using Unified Modeling Language activity diagrams. Notably, most primary care settings had unique workflows, with distinct workflows used to achieve similar goals.

In general, workflows in low-resource primary care settings can be complex and highly variable. In a study of primary care workflow, Holman and colleagues calcu-

lated an average of 37 tasks performed per visit, in no predictable order (Holman et al. 2015). Evidence suggests that starting small, seeking help from local resources focused on HIT, such as Regional Extension Centers (funded through the HITECH Act to assist with EHR implementation), and participation in other government-funded programs that provide incentives to implement HIT and consider workflow can all provide external resources to assist smaller practices with information integration and workflow standardization (Ramaiah et al. 2012).

In an international review of quality improvement studies conducted in low-resource settings, most studies were case reports with a focus on adoption and implementation, observational inquiries (qualitative inquiry of user and patient perceptions), and secondary literature reviews. Workflow assessments made up only a small fraction of these studies, indicating that there is a real gap in use of workflow to improve care processes, despite its demonstrated benefit (Jawhari et al. 2016).

Although there is still much to learn about specific factors that facilitate workflow measurement in small practices, studies evaluating facilitators of overall quality improvement have noted that general quality improvement activities are successful when the following factors are present: a dedicated "practice champion," involved practice leaders, clear team goals, collaboration between providers and staff, a sense of shared responsibility, and access to external resources such as learning collaboratives. Time constraints, costs, issues with HIT, a lack of staff motivation, and a lack of financial incentives are common barriers to quality improvement work, including workflow mapping (Wolfson et al. 2009).

Workflow in community health centers: Green and colleagues used cognitive task analysis interviews combined with observations of HIT implementation and semi-structured interviews to detect emergent themes to better understand challenges and facilitators related to IT workflow and maintenance (Green et al. 2015). Updates to HIT inevitably disrupt workflow and practices should prepared to manage these disruptions and adapt to HIT transitions.

Barriers to implementation of quality improvement strategies (including workflow assessment) can be categorized into situational (time, adverse effects on efficiency, culture, incentives), cognitive (fear of change, low perceived value), liability (privacy, security), knowledge (lack of training or knowledge on prioritizing systems to target), financial (high costs and low actual or perceive return on investment), technological (technical support, a lack of interoperability, limited reliability), and workforce (skillsets, leadership, organizational support). While cost of resources and expertise are prohibitive factors for urban and rural community health centers, rural community health centers also experience issues related to geography, wherein critical resources are not only unaffordable, but may be simply absent (Green et al. 2015).

10.2.5 Consumer Health Settings

Consumer health settings include "locations of daily living (LDL) such as workplaces, parks, exercise facilities, grocery stores," and even drug stores. Consumer health informatics (CHI) applications are powerful tools in consumer health

settings. They include mHealth apps, remote monitoring systems, personal health records, in-home monitoring devices, decision support systems, and online health resources. They provide individuals with easy access to personal health information, are a means of actively storing and monitoring patient health information and are an opportunity to engage patients beyond traditional healthcare settings (Cortelyou-Ward et al. 2012; Patrick et al. 2008; Radley et al. 1994). Widespread adoption of CHI is limited due to device inefficiency and their lack of patient-centeredness. Jimison and colleagues suggest adoption could be accelerated through improvements in usability, adherence to patients' mental models, and "better integration of CHI into patients' and families' daily routines," or workflows (Jimison et al. 2008). Historically, consumer health technology developers and researchers have considered the design and usability of these technologies through a highly medicalized lens that eventually accounts for personal behavior.

In order to leverage CHI and accelerate adoption, workflows in the consumer health setting must consider the more specific local contexts of information exchange. Zayas-Caban, Valdez, and their colleagues have explored a **patient work** framework, using human factors ergonomics (HFE) methods to build on existing medical-behavioral approaches and increase meaningful usage of CHI in the context of daily living (Valdez et al. 2015; Zayas-Cabán and Dixon 2010; Marquard and Zayas-Cabán 2012). At a minimum, a patient work framework should consider **physical, cognitive**, and **social-behavioral** activities in addition to **macroergonomic** (organizational) needs and constraints in consumer health settings (Marquard and Zayas-Cabán 2012). Consumer health workflows include:

- *Patient work activity*: These include family work and factors related to individual operation of and interaction with CHI. There are a few underlying assumptions behind patient work. First, both patient (and family) work and health professional work involve agency (implied opportunity to actively have a role in the performance of work), context, and activity. Next, patient work activity can be decomposed into illness work, everyday life work, and biographical work which are supported by coordination work. Activities can be visible (recognized and valued) or invisible (taken for granted and perceived by outsiders as less valuable).
- *Workflows*: These comprise the flow of health information across space and time and interactions with caregivers across space and time.
- *Patient work systems (context)*: The social and organization conditions and contexts in which health work is performed, including the structural components of task, technology, environment, and community. They can either constrain or facility work activity.

Take the example of using a pedometer application on a mobile phone. Physical ergonomics would include turning on a mobile phone's GPS or turning on the application within the context of a physical environment, such as a home or running track. Cognitive ergonomics considers factors related to processing information from the device's user interface (interpreting speed, calories burned, and distance walked or run). Macroergonomics considers the context within which the device is used. Design can affect one or more of the aforementioned human factors domains.

Viewing consumer health work through these categories can facilitate the design of better health technologies that support individual cognition. **Case-based human factors evaluation**, where patients or patient proxies record the nature and severity of challenges experienced while completing user tasks on a particular device, can assess the fit of a technology in a context of a patient's work and help to preempt important challenges in the usability of CHI.

10.3 Emerging Approaches to Workflow at the Edges of Care

Qualitative field-based methods such as interviews, observations, and activity log analyses, while rich in data, are time-consuming, labor intensive, and largely clinician-oriented. They also may not sufficiently capture information about patient experience and workflows across multiple care settings, particularly in consumer health settings. Still, these methods are widely used, particularly in transitional care environments. Moving forward, methods such as human factors engineering, social network analysis, patient-generated data, and use case-based human factors evaluation can augment current methods and make workflow assessment more efficient and high-yield for all individuals involved. We can also learn from complexity science and predictive modeling to better assess complex and variable workflows at the edges of care (Abraham et al. 2012; Goldberg et al. 2011).

10.3.1 Complex Adaptive Systems Approaches at the Edges of Care

Complex adaptive systems consist of individual entities, or "agents," which engage in dynamic, nonlinear interactions. The behavior of agents involved in a complex system cannot be predicted by the behavior of individual components. Furthermore, the self-organization and collective organizing behavior of components of a complex system contributes to our understanding of these systems as complex adaptive systems. Understanding the complexity of healthcare systems—where care is provided across multiple providers, multiple care settings, with significant variations across settings—is critical to our understanding of how we can improve care quality and patient safety in these settings, especially when considering workflow across institutions and care teams.

The nature of collaborative care delivery across multiple sites of services makes healthcare a complex adaptive system. As healthcare is a complex domain, complex adaptive systems (CAS) principles can and should be used to support healthcare management and improvement, specifically concerning workflow. A CAS approach encourages us to study issues and problems in terms not as isolated entities, but in terms of concepts (care providers, locations, information flows) and the rules of engagement for how the concepts interact within and across settings (Kuziemsky 2015; Kannampallil et al. 2011). Primary care is conceptualized

particularly well as a complex adaptive system due to its inherent variability and unpredictability.

Malhotra and colleagues have previously utilized a complex systems approach using functional decomposition on a series of complex workflows in an ICU. Activities were decomposed into the individual and collaborative or cross-organizational level. Cognitive requirements associated with those activities were considered. Once activities are decomposed, temporal sequencing of critical zones was used to determine relationships between the work activities. This additional variable (temporal sequencing and designated "critical" zones in the ICU) added an important layer of meaning that accounted for the complexity of workflow activities that may be ordinarily be considered in a discrete and linear matter. The identified relationships were then used to identify sources of errors or breakdowns and improve care processes (Kannampallil et al. 2011; Malhotra et al. 2007).

10.3.2 Patient-Centered Approaches

Overall, the needs and work activities of patients and their families are not sufficiently integrated into or measured in workflow assessment and associated system redesign (Levine et al. 2010). Ozkaynak and colleagues highlight how patient-centered or patient-oriented workflow studies may provide a more integrated understanding of healthcare work in formal and informal health settings (Ozkaynak et al. 2013). Clinician-oriented workflows focus on the specific activities of a single individual (the clinician) and are limited in their ability to capture all of the collaborative work, including a patient's work, involved in a care system. Conversely, patient-oriented workflow "define care delivery from the patient's perspective" (Ozkaynak et al. 2013). Benefits of patient-oriented workflow, especially at boundaries between care systems, include the following:

- Patient experiences represent a more accurate common "field of work" for the cooperative work of multiple providers and care teams.
- Patient-oriented workflow models cross, but can also more meaningfully define, system boundaries. Meaningful boundaries can help capture emergent features of care delivery such as cooperation and articulation, thus reducing variability that must normally be accounted for in clinician-oriented workflows.
- Patient-oriented workflow models can characterize the spaces between the "edges of care" and can also improve our understanding of less-studied settings such as locations of daily living.

Valdez and colleagues synthesize how patient work frameworks used to assess work activities (integral to patient workflow) in consumer health settings can be integrated into user-centered design processes. This approach can improve capacity for problem analysis, conceptual design, development and formative evaluation, and summative evaluation and monitoring. Workflow analysis can then be used as a tool to integrate information sourced from CHI and better understand associated patient and family work (Valdez et al. 2015).

- *Problem analysis*: Field research in a patient's home and other community settings can help integrate patient and family perspectives and priorities into health technology design, especially since CHI technologies are used primarily outside traditional clinical settings.
- *Conceptual design*: Community-based or community-informed informatics interventions can provide more accurate information related to the contexts in which health technologies are used by patients and families
- *Development, evaluation, and monitoring*: Participatory design sessions with patients and families, especially high-need or vulnerable populations, can integrate multiple "interconnected participants" such as patients, their families, and providers, into the design process.

The health system Kaiser Permanente has utilized case study video ethnographies to study workflow in a novel way and improve care transitions (Neuwirth et al. 2012). Rapid video ethnography was used to study transitions between settings and complement workflow mapping. Their four-step process effectively triangulated qualitative and quantitative measurement strategies. It included planning and design based on a clearly defined project, fieldwork (interviewing, observing, and video recording), data analysis (paired with identification of improvement opportunities), and video editing based on key themes and selected improvement opportunities.

10.3.3 Human Factors and Ergonomics

Human factors and ergonomics (HFE) methods help us consider patient, family, and provider strengths and limitations in the design of healthcare systems and technologies. This approach has been used for decades to improve care quality and safety in healthcare. The Systems Engineering Initiative for Patient Safety (SEIPS) model is an HFE systems approach that incorporates Donabedian's Structure-Process-Outcome model of care quality (Donabedian 1988). It includes an individual's external environment (structure/work system), care and other processes (process), and patient, employee, and organizational outcomes (outcomes). The SEIPS conception of external environment includes persons, tasks, organizations, the physical environment, technology and tools. It is an adaptable model that accounts for multiple healthcare domains, emphasizes systemic impacts, is flexible across various work systems, and provides a broad view of processes incorporating multiple work system elements (Carayon et al. 2014).

10.3.4 Social Network Mapping to Prioritize Target Areas

Small network mapping is a method that used analyze and interpret small networks of providers and practices. Recent efforts have evaluated case studies relevant to the edges of care: one of networks of patient handoff communication and the other of

networks of interorganizational ties in primary care. Simple validation techniques can address the variability inherent in small networks and compare across networks. Network mapping conducted between organizations, focused on transition points with particularly high vulnerability (as evidenced by patient outcomes such as adverse events), can be used to determine the presence of a central coordinator of specific activities. This approach could in turn provide a basis to more specifically study workflows, reengineer workflows and drive policy changes within networks (Dunn and Westbrook 2011). Other approaches have used social network analysis more specifically to characterize the frequency and type of communication patterns between providers and patients, as well as the network of communication patterns between providers and patients during transition processes (Pinelli et al. 2015).

10.3.5 Cross-Organizational Workflow

Promoting local health information exchange (HIE): HIE provides the promise of readily available relevant medical and social information that bridges care settings. It may eventually help patients and providers with adherence to treatment recommendations, reduce waste, errors, and previously discussed issues of missing information. Currently, data exchanged between HIE, hospitals, and other healthcare settings is minimal and still mostly inaccessible to patients and their families. Clinical information is still largely heterogenic and data sharing is not sufficiently collaborative. Understanding factors that promote or prevent HIE implementation at the edges of care could accelerate our transition to a system where HIE is easily available, accessible by patients, families, and their care teams, and accurate (Jensen 2013). Workflow implementation challenges have hindered HIE participation, although implementing HIE may provide the opportunity to add new or improve existing workflows. Accountable care organizations, which include multiple sites of service, are driven by federal policy goals to recognize the importance of health technology implementation and coordination across care settings. Workflow assessment of care management processes could improve care quality and safety for their patient populations (Rundall et al. 2016).

Process-oriented coordination of care across organizations: Tello-Leal and colleagues recently developed a methodology to integrate cross-organizational healthcare services between generalist and specialist care. The methodology utilized Model-Driven Architecture, Petri Net specification and definitions of clinical documents using HL7 Clinical Document Architecture, housed on a coordinated software platform. The methodology included three phases: first, healthcare organizations involved defined an "integration agreement," which identified requirements and goals, processes, and clinical documents required across organizations. An integrated technological solution was then used to design the identified processes, define clinical documents, and design integration processes. The methodology can guide organizations to more specifically define care integration, define artifacts required in care integration, and automate patient referrals across settings (Tello-Leal et al. 2012). Though complex and resource-intensive, this approach has

the potential to directly integrate processes across boundaries of care. Further development of similar approaches using scalable technologies could be one day replicated in other care settings.

10.3.6 Leveraging Local Resources and Funding

The resource limitations currently faced by smaller primary practices and community health centers limit workflow assessment and implementation of HITs which can promote improvements to care quality and safety (Young et al. 2017). In addition to leveraging local and federal funding dedicated to EHR implementation and adherence to Meaningful Use guidelines (Regional Extension Centers), external partnerships with universities and large health systems may better distribute resources and expertise related to HIT and workflows. There is also a potential to train and engage non-clinical staff such as patient advocates and navigators in these efforts.

10.4 Conclusion

There is significant discontinuity and fragmentation between different sites of service within healthcare, but limited documentation of workflow (1) in low-resource care settings, (2) between care settings, and (3) outside of care settings. Workflow analysis, especially patient-oriented workflow, can be used as a tool to better characterize and address these gaps. To equitably improve quality and safety of patient care across different care settings, there is a need for automated and mixed-methods approaches that continuously leverage existing data, account for the nuances and resource limitations at the edges of care, and ultimately reach across the continuum of the healthcare systems. Health information exchange, interorganizational collaboration and cross-sectoral collaboration will all be required in order to map workflow across settings. At the end of the day, clinicians and researchers should and must leverage the fact that the patient is central to all care delivery.

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