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Health IT Workflow Automation

WORKSHOP SUMMARY REPORT

Advancing Health Care Using Automation: Opportunities with Modern Computing

Prepared by Clinovations Government + Health (CGH) for the Office of the National Coordinator for Health Information Technology

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Executive Summary

The landscape of automation across health and non-health industries has evolved to improve value and reduce costs. Modern computing capabilities, such as big data analytics, artificial intelligence, robotics, and wearable sensors, have been adopted by several non-health care industries to successfully automate workflow. The health care industry has experienced some automation of operations and administrative workflows. However, in other domains, such as clinical decision making, patient and provider interaction, and population health, fewer workflows have experienced automation.

Expanding automation through modern computing opportunities has the potential to support more efficient health care workflows. Among the potential benefits are reductions in clinical burden and overwork of health care professionals on the job and after hours, as well as patient participation in shared decision making through streamlined access to information. Non-health sectors already supported by automation can offer insight into how to automate health care processes effectively and successfully, including identifying potential barriers and recommendations for stakeholder buy-in.

This report was prepared for the Office of the National Coordinator for Health Information Technology (ONC) to explore opportunities to propel workflow automation through the use of modern computing. The first part of this project involved taking a rigorous and deliberative approach to a series of tasks focused on understanding opportunities for workflow automation in health care, including:

- Eight semi-structured interviews conducted with automation experts across multiple industries in November and December of 2019;
- A targeted literature search drawing from sources within and outside of health care, including peer-reviewed journals, gray literature, issue briefs, government reports, conference proceedings and presentations, and web-based materials; and
- A multi-disciplinary expert workshop on September 14th and 15th, 2020, to provide input on topics for workflow automation in health care.

Workshop participants represented fields within and outside of health care, including engineering, human factors, technology, finance, robotics, aerospace, and aviation. Workshop discussions focused on the characteristics of workflows that make them well-suited for automation; the health care workflows for automation, including their appropriate level of automation; and the market and policy levers that the private and public stakeholders could support and encourage to advance workflow automation. The key themes that emerged follow for validation by workshop participants.

Automation approaches should:

- Identify the goals of automating a workflow and ensure they can be measured;
- Involve the humans impacted by automation, including clinicians, patients, and caregivers, in the design to thoroughly understand the level of intervention in a workflow;
- Preserve the role of human judgement by pursuing partially-automated workflows;

- Facilitate widespread automation and industry-wide gains through similar levels of technology adoption across coordinated organizations; and
- Apply automation cautiously where workflows involve risk for adverse consumer outcomes.

Automation across patient, clinical/care delivery workflows, and population health workflows should:

- Improve the experience of workflows;
- Reduce burden associated with rote tasks;
- Support decision-making;
- Prioritize patient safety; and
- Improve availability and completeness of data to support care decisions.

In considering workflow automation market and policy levers, two overarching themes emerged. Health care workflow automation 1) must increase efficiency and reduce costs while driving improvements in outcomes and quality of care; and 2) requires a process to identify a set of agreed-upon goals.

Workshop Overview

STRUCTURE

Dr. Don Rucker and Dr. Teresa Zayas Cabán opened the virtual workshop with welcoming remarks to frame the workshop. A keynote address by Dr. Mary Cummings, Professor at Duke University's Department of Electrical and Computer Engineering, discussed the successes and ongoing challenges for automation across non-health care industries employing autonomous systems. Two moderated panels focused on automation approaches and workflows to automate, followed by break-outs on the same topics and facilitated discussion with the full workshop. On the second day, a panel of invited speakers from Kaiser Permanente spotlighted automation initiatives across their clinical and administrative enterprises. A moderated panel and subsequent break-out on market and policy levers to support workflow automation followed, with full discussion to conclude the workshop. The agenda is available in Appendix A.

PARTICIPANTS

Workshop participants included individuals whose expertise and experience with workflow automation or health care positioned them to contribute to the workshop discussions. The list of attendees is in Appendix B. Nineteen participants came from health care fields, across delivery, health information exchange, payment, administration, technology, and patient advocacy. Seven participants came from outside of health care, representing fields across engineering, human factors, technology, finance, robotics, aerospace, and aviation. The workshop included ONC leadership, who participated throughout the duration of the workshop's presentations, panels, and break-out sessions. The workshop involved a total of 32 attendees.

PARTICIPANT ORIENTATION

Prior to the workshop, a background report on workflow automation, entitled *Workflow Automation: Industry Lessons for Health Care*, was distributed to workshop participants and posted on the virtual hub's landing page. The report addressed workflow automation opportunities based on interviews with experts and a literature search. The workshop's organization and content was derived from this report, with a focus on automation approaches in non-health care industries and factors to consider for automating clinical workflows. Based on the report's method to organize findings by *people*, *process*, and *technology* categories, the second day's break-outs followed the same format to identify and evaluate potential market and policy levers in these areas to support workflow automation.

Workshop Summary

AUTOMATION APPROACHES

A central premise of the workshop was understanding non-health care industry methods and approaches to workflow automation, including the factors that make workflows well-suited for automation and criteria to select and prioritize workflows for automation. Workshop participants heard panelists representing expertise across finance, robotics, and manufacturing discuss the role of humans in designing and participating in a range of low, partial, and fully automated workflows; the benefits of technology standards and technology adoption; the importance of measurable goals; barriers to automation; and other topics related to automation approaches before engaging in small break-out discussions. This section presents those topics, as well additional approaches from other industries that the health care industry can use to inform automation.

Key themes and concepts that emerged emphasized that automation approaches should:

- Identify the goals of automating a workflow and ensure they can be measured;
- Involve the humans impacted by automation, including clinicians, patients, and caregivers, in the design to thoroughly understand the level of human intervention in a workflow;
- Preserve the role of human judgement by pursuing partially-automated workflows;
- Occur where there are similar levels of technology adoption across organizations to facilitate widespread automation and industry-wide gains; and
- Apply automation cautiously where workflows involve a degree of risk for adverse consumer outcomes.

Characteristics of Workflows Well-suited for Automation

The workshop discussions identified key characteristics that make certain workflows well-suited for automation:

- **Limited human judgement and intervention**. The degree to which a human is needed "in-the-loop" at critical workflow decision-points affects the degree to which automation can be achieved. The workshop discussion highlighted the importance of selecting the practical processes to partially automate and preserving the role of judgement for humans.
- **Widespread technology adoption**. Widely adopted technology standards and similar levels of technology adoption and use across an industry are two factors that support workflow automation. Minimal standardization is synonymous with increased workflow variability, and increased variability decreases the extent to which a workflow can be automated. These factors not only make workflow automation easier at individual organizations, but they facilitate widespread automation across organizations in a more scalable manner.

- **Minimal risk to consumers**. Well-designed and properly implemented automation itself should not create a risk to adverse outcomes; however, workshop discussion frequently focused on the topic of risk to consumers and tended to conclude that that the level of automation for workflows that involve risk should be commensurate with the maturity level and trust in the automation tools. Participants emphasized the importance of identifying all potential points of risk in a workflow prior to its automation.
- **Analysis of group or population data**. Workflows that streamline the data collection, analysis, and decision-making for groups of individuals should be strongly considered for automation, due to their opportunity to reduce workload and improve population health.
- **Measurable and distinct goals**. Measurable goals for automation are critical to inform design, and identifying conflicting goals (such as reducing labor costs and improving productivity) avoids waste.

The workshop discussions validated findings from the background report distributed to participants prior to the workshop and interviews with experts on the characteristics of workflows that make them well-suited for automation. Workflows to prioritize for automation:

- Involve manual data entry;
- Occur with high frequency and/or repetition;
- Use clearly defined independent and dependent variables for modeling; and
- Have clear roles and responsibilities.

To the first two bulleted points above, workshop discussions emphasized that, when automated, workflows with frequent and repetitive tasks can increase efficiency and produce value for humans. To the last two bulleted points, the workshop participants reiterated that processes with clear input and outputs are easier to bound and discretize with clear roles and responsibilities, making their structure generally well adapted to technology support systems.

Lastly, workshop discussions commonly agreed that end-user confidence, support, and engagement in automation design and implementation are crucial aspects of successful implementation. A user-centered design of the technology supporting automation was encouraged to facilitate end-user adoption. The participants emphasized involving as many stakeholders as possible in the automation design and implementation process for successful automation.

Factors Specific to Automating Health Care Workflows

Workshop discussion frequently recognized health care-specific industry factors to carefully consider in designing automation approaches. These considerations echoed the pre-workshop expert interviews and the background report, which identified the aspects of the health care industry that differentiate it from other industries and translate to concerns related to automation:

- Potential for harm to patients attributed to automation;
- Critical need to protect patient privacy and data security in highly automated workflows with little human involvement;

- Complex underlying data to support automation;
- Variation in workflow across facilities and practices, organizations, and regions; and
- Importance of experiential and clinical judgement for clinicians.

Lastly, workshop discussion raised the topic of differences in generational perception of automation based on lifetime experience with technology. Incoming generations of health care professionals have used technology, such as tablets and smartphones, for most of their lives and are generally comfortable with their operation. On the other hand, many health care workers and patients do not have the same experience with such technology. Depending on the technology involved, lack of familiarity with technology may result in automation pushback, especially if they are comfortable and satisfied with their current working standard.

WORKFLOWS TO AUTOMATE

The workshop sought to generate insight on the health care workflows that are important to automate. Participants heard from a panel that shared perspectives on a range of workflows to automate, as well as from invited Kaiser Permanente speakers, who provided examples of administrative and clinical workflows that had improved operations and care delivery for its enterprise.

Recognizing that health care delivery occurs within and outside the four walls of hospitals and clinics and that it involves many stakeholders and types of workflows that could be automated, the workshop focused on three overarching categories that involve clinical, administrative and data analytics components: 1) patient and caregiver workflows, 2) clinical/care delivery workflows, and 3) population health workflows.

Discussion about workflows to automate reiterated the overall vision of the workshop: automation should increase efficiency, improve health outcomes, and deliver value for stakeholders. Specifically, the key themes that emerged across patient, clinical/care delivery workflows, and population health workflows were to:

- Improve the experience of workflows;
- Reduce burden associated with rote tasks;
- Prioritize patient safety; and
- Improve availability and completeness of data to support care decisions.

Patient and Caregiver Workflows

Participants envisioned a system where automated workflows reduced errors, decreased the amount of time to access and exchange health information, improved the social and physical health of patients, reduced disparities in health care access and outcomes, and elevated the importance of the work patients conduct to manage their care as the central actor. Goals for automating workflows focused for patients and caregivers (including patient advocates, families, and legal guardians) emerged as:

- Increasing shared decision making and patient activation by making patient health information more quickly and widely available and by streamlining the administrative tasks to sign-up for and manage the privacy, security, and use features of portals and application programming interfaces (APIs);

- Improving patient safety by expanding means and norms for patients to verify information in provider records;
- Bring the flow of information and the workflow of appropriate care into harmony;
- Equipping caregivers with access to health information when patients are unable to manage their health; and
- Improving the patient experience and interaction with payers and providers by facilitating seamless integration of information.

Table 1 identifies the workflows that arose through workshop discussion to advance the goals listed above. Where specifically noted by a break-out or other component of the workshop, a level of automation to consider was identified. Some of the workflows would require instrumentation (e.g., care process "dashboard" and semi-automated bots), while others entail automating processes that have evolved in the years since the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 (e.g., permissions to access and share data).

Table 1: Patient and Caregiver Workflows to Consider for Automation

Workflow	Rationale and Level of Automation
Management of permissions to access and share electronic health data	• Enable patients and caregivers to more quickly access their data and control its transfer to third party apps and other providers without relying on care providers and paper-based systems • Empower patients and caregivers to be active participants in their care and verify provider data • Level of automation to consider: High
Post-encounter care coordination	• Ensure care management and monitoring processes are immediately underway after ambulatory and inpatient encounters to improve health outcomes • Connect patients and caregivers with advocates and community and non-clinical resources for social needs • Level of automation to consider: High to semi-automated
Care planning	• Facilitate information sharing, communication, data verification, and decision-making with care teams • Level of automation to consider: Semi-automated
Billing and payment processes	• Streamline, simplify, and bring transparency to costs from providers and payers • Level of automation to consider: High
Customer service bots	• Reduce burden on providers and administrative staff for scheduling and other tasks that support care delivery • Provide digestible information in patient friendly terms and venues • Level of automation to consider: High
Preferences applied across automated workflows	• Improve patient experience • Ensure critical messages are received, understood, and acted upon • Level of automation to consider: High

Lastly, workshop discussion commonly emphasized that, while there are relatively simple and straightforward workflows to automate, those should not replace a "re-imagining" of workflows that involve more complexity, would entail long-term time frames to impact inequities in health access and outcomes, and would accelerate opportunities for patients to play a more central role in their health and health information management.

Clinical and Care Delivery Workflows

Throughout the workshop, discussion frequently acknowledged that automating clinical workflows requires acceptance and buy-in from clinicians. This calls for automation that 1) upholds strict and high levels of patient safety; 2) preserves the role of clinical decision-making; 3) improves situational awareness for care management; and 4) improves clinician experience with workflows by synchronizing access to needed information.

The discussion emphasized pursuing appropriate levels of automation. Clinical workflows that involve decision making can be more challenging to fully automate, due to the four factors listed above. Participants suggested that the best strategies would focus on making clinical decision-making easier, rather than on fully automating a workflow. There was general consensus among participants that semi-automated workflows were most appropriate for workflows involving clinical judgement because of the necessity for precise underlying automation design and complete, accurate supporting data.

The workflows identified in Table 2 for automation to support clinicians and health care delivery organizations complemented some of the workflows to support patients and span patient-care and administrative aspects.

Table 2: Clinical and Care Delivery Workflows to Consider for Automation

Workflow	Rationale
Telehealth and virtual health	• Extend remote monitoring across the care spectrum • Transform care delivery across settings with monitors and alerts that notify patients, caregivers, and their providers of an appropriate visit based on wearables, sensors, and other available technologies • Use bots to schedule and onboard patients to virtual health platforms, such as apps
Inpatient and outpatient decision making workflows	• Streamline data collection, review, and translation into practice (for example, synthesizing more than 20 parameters for starting extubation) • Reduce "hunter/gatherer" burden on clinicians to locate missing data to support real-time care decisions
Encounter follow-up tracking	• Streamline follow-up schedules for clinical reminders to eliminate reliance on work-arounds, such as Excel spreadsheets for procedure reminders, that reside outside the EHR

Workflow	Rationale
Inbox triage	• Reduce inbox monitoring by assigning messages to appropriate care team members and administrative staff and tracking their responses
Scheduling	• Improve appointment scheduling to better understand and respond to condition severity and requests for medical records prior to scheduling
Care team member collaboration and communication	• Reduce duplicative information gathering by streamlining check-in, registration, and rooming processes

Population Health Workflows

Population health workflows involve use of tools, algorithms, and visualizations to facilitate a provider's understanding of their patient population and the implementation of targeted interventions to improve health for groups of individuals cared for by clinicians. The following goals of automating population health workflows emerged from workshop discussion:

- Support preventive- and chronic disease management initiatives by expanding technology and available human resources;
- Support providers in understanding the role of social determinants of health and equipping them with population-based interventions;
- Address "data blind spots," by enhancing provider access, understanding, and use of data from non-clinical sources (school-based clinics and justice system) to inform care; and
- Improve affordable access to sophisticated population health tools and risk stratification methods.

Workshop discussions emphasized that providers and patients must be incentivized and supported in collecting, sharing, storing, and exchanging information to support population health. They suggested that workflow automation around population health could streamline and assist population health efforts, particularly by making consent collection processes for data sharing more transparent for patients and more manageable for providers.

Table 3: Population Health Workflows to Consider for Automation

Workflow	Rationale
"Define" the patient	• Enable care providers and delivery organizations to understand "data blind spots" and provide "life-focused" care • Facilitate widespread availability of sophisticated population health analytics tools and data
Streamline interoperability with non-clinical data sets	• In support of the workflow detailed above, provide innovative ways to advance understanding of social determinants of care • Exploit workflow models to understand precision data requirement for interoperability (what and where).

Workflow	Rationale
(for example, schools and the justice system)	
Advance use of customer relationship management for communication, information gathering, and identify verification	• Reduce use of paper forms and processes that require providing the same administrative and/or clinical information multiple times • Consistently collect and support use of information regarding patients' communication needs and preferences, such as primary language or method of contact
Reporting registry, public health, and quality measurement data	• Reduce manual burden associated with report development, generation, and transmission • Decrease length of time to share public health and quality measurement data

MARKET AND POLICY LEVERS

Following the first day's focus on automation approaches and workflows to automate, on Day 2, the workshop transitioned to focusing on strategies to support workflow automation. In considering these strategies, participants were asked to identify and discuss market and policy levers that are essential to advance the strategies that support workflow automation in health care. Guided by an expert panel discussion, four break-out groups of participants explored the following topics:

- **People:** Stakeholders essential to supporting workflow automation including, but not limited to, patients, caregivers, clinicians, administrators, technology developers, payers, and public decision-makers;
- **Process:** Organizational requirements for planning and implementing workflow automation (physical and technical infrastructure, resources, staffing, financial incentives); and
- **Technology:** Technologies and technical infrastructure (e.g., standards, solutions) to support workflow automation.

Beyond the people, process, and technology categories organized and presented below, two overarching themes cut across these categories. Health care workflow automation 1) must increase efficiency and reduce costs while driving improvements in outcomes and quality of care; and 2) requires a process to identify a set of agreed-upon goals utilizing input from all affected stakeholders.

Two additional lever themes and concepts frequently emerged across workshop discussions:

- Although the workshop's scope did not include an explicit focus on the organization and structure of health care financing in the United States, participants frequently commented that there is a lack of clear payer incentives to finance the people, process, and technology efforts required for workflow automation, and this complicates the business case for these initiatives. Health care automation is focused on increasing efficiency and reducing costs, but it must also drive improvements in outcomes and quality of care delivered to individuals and populations. However, these stakeholder types are not positioned to be the primary funders and contribute to ongoing sustainability. Workshop discussion highlighted that the design of innovative technologies is usually pursued and financed to increase revenue and incentives; innovation is rarely driven by cost-savings. These dynamics contribute to macro and behavioral economics that confound efforts to design and implement effective strategies and levers for workflow automation.
- Secondly, workshop discussion frequently referenced the need for a process to identify a set of agreed-upon goals for workflow automation. Whether the conversation was about an individual organization's automation or a national scale initiative, workshop participants stressed the importance of articulating a set of specific goals, inclusive of the patient and caregiver perspective, to guide automation priorities. They emphasized that people, process, and technology strategies should be selected and fine-tuned based upon specified goals for automation.

People Levers

Stakeholders

Throughout the workshop, participants discussed the stakeholders critical to informing, planning, implementing, and maintaining workflow automation initiatives. Feedback was clear that "upstream" and "downstream" stakeholders affected by automation of workflows must be considered. Whether or not an individual or group directly participates in a workflow to be automated, identifying all stakeholders and determining the level of impact on each one is important when considering effective approaches to advancing workflow automation.

Stakeholders include, but are not limited to:

- Technology resources, including data source stewards, developers, and standards organizations;
- Patients and caregivers (including patient advocates, families, and legal guardians);
- Clinicians, including physicians, nurses, and mid-level providers across the care continuum;
- Non-clinical care providers, including patient advocates, chaplains, personal trainers, coaches, social workers, case managers, care coordinators, dieticians;
- Administrators and operations professionals, including workflow and process engineers, office managers and staffs, and utilization/compliance managers;

- Payment and reimbursement professionals;
- Public decision makers, including state and federal authorities and certification bodies; and
- Professional societies.

Across both days of panels and discussions, the workshop identified patients and caregivers as critical stakeholders. These stakeholders have generally low levels of empowerment that can lead to bias in workflow automation design. Discussion urged that any automation efforts keep in mind that 1) patients have a range of capabilities and access to technology; and 2) the patient experience exists on a spectrum.

Motivators

Stakeholder motivators to pursue workflow automation were also discussed broadly. Because some motivators applied to more than one group of stakeholders and levels of influence varied, the factors listed below are not prioritized or assigned to specific stakeholders.

- "Soft" motivators that indirectly encourage workflow automation
    - Professionalism: Eliminating inefficient workflows - it is the right thing to do for patients and workers
    - Desire to create and enable a positive user experience with technology and streamlined processes (e.g., joy, delight, satisfaction, peace of mind);
    - Institutional roles and power
    - Reputation for individuals and organizations through rankings, positive reviews, recruitment
    - Organizational mission
- Codifiable, "hard" motivators from external entities
    - Financial incentives
    - Testing and certification
    - Enforceable penalties and regulations
- Financial motivators internally relevant to an organization's operations and strategy
    - Profit and cost savings
    - Market share and competitive advantage
- Measurable results and transparency (public reporting) motivators
    - User loyalty and satisfaction
    - Outcomes
- Technology motivators
    - Standards and capabilities that enable transparency, interoperability, and security
- Clinical care motivators
    - Reduction of clinical burden
    - Increased data via enhanced data mining processes
    - Quicker access to computable data to support decision making

Deterrents

Deterrents to workflow automation also impact stakeholders, causing them to withhold or stall support from automation efforts. The workshop identified the following stakeholder deterrents.

- Clinicians and other care delivery stakeholders
    - Dehumanizing of health care and removal of workflow aspects that benefit from narrative data (as opposed to structured data)
    - Increased patient volume targets or caseloads as a result of improved clinical efficiencies produced by automation
- Decision-makers in public authority and executive administrative roles and clinicians
    - Automation introducing “game the system” opportunities
    - Lack of transparency from within a “black box” hampering support
    - Poorly designed, inefficient workflows being automated
    - Automation further entrenching fee-for-service payment models
    - Large scale automation resulting in widescale economic impact due to job loss and role changes
- Stakeholders in technology roles
    - Automating inefficient processes
    - Lack of technological readiness for workflows supporting human decision making (for example, removing bias in AI through testing)
    - Introducing new, significant cybersecurity threats

Participant Recommendations and Observations

The workshop yielded observations and suggestions for how these motivators and deterrents could be translated into strategies to support workflow automation.

- Discussion emphasized that the introduction of large-scale automation is often perceived as a deterrent if it produces widespread job loss; however, it is also an opportunity to enable humans to work at the top of their skillsets and be repurposed to perform tasks requiring human judgement and intervention.
- Decision makers in public authority and executive administrative roles were advised to pursue regulation and/or certification approaches through a process that includes input and coordination from health IT developers.
- Decision makers in public authority and executive administrative roles were advised to use their influence to build consensus and set a broad vision based on defined and carefully curated priorities and metrics and supported by design methods that encourage private innovation and promotion of automation successes.
- Workflow automation holds the potential to accelerate health care automation to the levels that stakeholders, such as clinicians and patients, are used to seeing when they interact with other industries, such as hospitality and finance.

Lastly, workshop participants expressed the hope that future generations of the health care workforce would be excited to pursue clinical care careers, alongside a generation of engineers encouraged to apply their expertise to health care workflow challenges.

Process Levers

To identify the process levers necessary to support workflow automation, participants considered the organizational needs required for planning and implementing workflow automation. Discussions focused on operational, physical, human, and technical resources, as well as variations across organizations within each of those areas. The following key requisites emerged to support workflow automation processes:

- Measures that map to organizational goals that can be standards that industry stakeholders (e.g., technology developers, startups) can use to guide the development, testing, and ongoing evolution of workflow automation capabilities;
- Human resources, including
    - Skilled staff with systems design, industrial engineering, and process improvement expertise,
    - Business side with understanding of the profit margins, and
    - IT knowledge with ability to understand and leverage organizational data; and
- Technical capabilities and knowledge of data capabilities to re-examine existing workflow processes as a starting point for discovering, identifying automation, and simulating opportunities.

Discussions regarding market and policy approaches from industries outside of health care reflected on service industry automation examples implemented by hotels (check-in process), amusement parks (customer access and people flow), airlines (flight scheduling, airliner safety improvements), public transportation (supply chain), and package delivery (customer data). In these service industry examples, customer safety and profit margins were primary drivers for automation given the competitive nature of these markets. Some participants cautioned comparing health care to other industries as the local nature of health care delivery and patient populations make it difficult to extrapolate automation across locations with varied literacy, language skills, and digital connectivity. Another unique health care variable is the opportunity to use policy levers to ensure the best outcome for patients. In overnight package/mail delivery market, the winner who delivers better, faster, cheaper ultimately increases its market share. Meanwhile in health care, if the payer makes market decisions, it distorts the system, versus supporting an ability for consumers to be more informed in their care and support higher efficiencies.

When asked how the process aspects of workflow automation was best supported, participants pointed out that health care delivery organizations vary in the human, technical, and financial resources that support workflow automation. Such variance could increase disparities between health care organization “haves” and “have-nots” and negatively impact patients receiving care from organizations with fewer resources to invest and maintain automation solutions. Participants noted that care had to be taken so that workflow automation benefits would be available to every health care organization and the patients they serve.

Participants suggested that a "playbook" could help organizations conceptualize and plan their approach to workflow automation. A playbook would help organizations consider workflow automation goals in terms of existing resources, procedures, and culture. Participants viewed this approach as particularly useful for organizations lacking in-house resources or where workflow automation is not a familiar or intuitive concept. Participants also urged caution against an over-prescriptive approach that created or promoted unscalable initiatives beyond the capabilities of a single or small group of health care delivery systems. A set of national metrics and technology standards to encourage across organizations was recommended to address the concern of fragmented, unscalable efforts. Recommended "playbook" components included:

- Approaches for how to determine what to automate and how to design the new workflow;
- Processes that are amenable to workflow automation;
- Examples and insights for how to develop teams;
- Recommendations for people and infrastructure needed to inform, design, and implement automation, including clinicians and patients; and
- Methods for measuring success.

Participants also discussed their experiences that apply to how organizations may perform a "de novo" discovery of workflows to automate. Many participants that represented health care provider organizations had workflow redesign (e.g., as-is/to-be, LEAN) experience and noted its value in discovering pain points. However, the challenge is in training people in the information, equipment, and people/roles that are involved in fixing the pain points. Participants discussed the automation opportunity in using EHR log files to measure time, screen latency, variability, and safety issues. Data that offers the ability to discover the amount of work spent on coordinating an activity (i.e., workflow) provides valuable insight on what may be automated.

Technology Levers

Throughout the workshop, participants discussed the technologies and capabilities required to support automated workflows. The workshop's goals did not include conducting or compiling a comprehensive review of available technologies (e.g., articial intelligence (AI), robotics), nor did it aim to assess the readiness of current computing technologies to support workflow automation. Rather, the workshop's facilitated discussions were designed to reveal common themes about the role of technology in workflow automation, informed by the expertise and experience of the participants. Participant comments underscored four essential concepts for successful use of technology for workflow automation.

1. Technologies for automating workflows already exist today and these technologies can be applied to health care.
    - There is not a need to wait for advancement or readiness of modern computing technologies. Participants offered general consensus regarding the notion that the technology is readily available and works well in other industries such as manufacturing, but where progress is needed to support health care is in handling the variability and "looseness' of health care processes.

- Modern computing technologies are often used for very defined and narrow use cases. Health care will still require humans-in-the-loop when using these tools and technologies. Business process management (BPM) automation tools focus on command-and-control of workflows. There is a movement decentralize processes at a large scale; however, the industry around this is still evolving.

2. Workflow automation initiatives should be driven by automation priorities, goals, and desired results.
    - Workflow automation initiatives should be driven by automation priorities, goals, and desired results. That information, in turn, should be used to select the appropriate technology. Participants warned that automation initiatives struggle to achieve widescale application if they are built around a single innovative technology that is then applied to a narrowly defined workflow.
    - There was consensus among workshop participants, the keynote speaker, and other expert presenters that while offering significant promise, some modern computing technologies, such as AI, have challenges and flaws that must be overcome. Autonomous systems have to be programmed to see and navigate the world in the way that humans do. However, computerized systems are limited in their ability to conduct top-down reasoning, and by flaws related to bias in the design of AI. Although solutions are actively underway and progressing, they can be tedious, resource intensive, and prone to their own testing biases and limitations.

3. Reliable, comprehensive data is an essential asset for workflow automation.
    - Participants discussed data as a critical driver for workflow automation design, and participants cautioned against implementing technologies without first thoroughly understanding data as the source of truth, knowing where it resides, and how it is captured. Automation approaches and supporting technologies informed by a strong data foundation have the capacity to more rapidly establish acceptability and trust. This is particularly important for automating decision-making processes that impact clinicians and patients.

4. Data must be accessible to technology designers and users via standardized interfaces and other interoperable methods to integrate modern computing technologies (such as AI) into workflow automation.
    - Participants felt that workflow automation holds the greatest promise when it can be applied across health care delivery organizations to drive widescale improvements and benefits. The message that resonated across workshop discussions was that individual stakeholders – including clinicians, patients, caregivers, delivery organizations, and payers – cannot sustain multiple automation approaches. Market and policy levers that support standardized data and encourage flexible, adaptable technologies can help to address fragmentation across the US health care system.

In addition to these overarching themes on the role of technology to support workflow automation, participants offered the following observations and dynamics to inform market and policy levers:

- **Privacy and security**: Technology must be able to manage security and privacy requirements and be designed to remove flaws related to bias in design. Currently, risk aversion to negative outcomes and conservative approaches to information sharing are deterrents for workflow automation.
- **Automation expertise and equity**: Health systems do not have the same level of access technology personnel to use the technology to its full potential and analyze the data. Workshop participants expressed concerns about equity for providers in rural and underserved areas and suggested workforce development as a potential supporting lever.
- **Data availability and access**: The data supporting workflow automation will be highly valued by designers and implementers. The resulting data will also be highly valued for analytics. Workshop participants recognized these dynamics and emphasized that, currently, it does not move between these entities.

Data standards: Available standards such as Health Level 7 International (HL7®) Fast Healthcare Interoperability Resources (FHIR®) can help users understand the data that is available or retrieved from health IT systems, but automation needs insight into how quickly the data will be available, how the data can be accessed, and how data can be created or written. Health care data is highly complex, and errors have greater impact in comparison to other industries.

Participants emphasized the current state of automation in health care is not a "technology barrier" and focused on areas to consider in driving technology adoption to support automation:

- Why automate using technology?
    - Who wants to build it and why?
    - Who wants to give the approval to deploy the technology to health systems?
    - Who wants to maintain it?
    - What incentives are needed to maintain the technology and not deprecate it?
- Why do health care technologies or standards not get advanced or adopted?
    - What are other competing standards or priorities? (e.g., Meaningful Use, FHIR®)
    - How to educate and build demand for a technology or standard from the bottom up? There is not a mechanism to promote technology that can advance automation.
    - While an increase in mindshare of people who are interested in a technology may happen, translating this interest to adoption and deployment is a challenge.
    - Increasing revenue and making (new) money is a stronger motivation than saving money.
- What drivers and motivators (within and outside of health care) supported technology that was or is adopted?

    - Health care stakeholders are generally risk adverse and technology buyers seek established products and solutions that others have implemented and used successfully.
    - Determine whether there are policy levers that can help reduce anxiety and fear. (Participants noted the Kaiser Permanente examples were incented to implement workflow automation and had top-down drivers to create APIs.)
    - Without a reimbursement push, “bottom up” doesn’t happen much in health care – where can there be more experimentation (e.g., accountable care organizations (ACOs), CMS innovation) that can provide models and flexibility to try new technologies.
- Other considerations
    - Who are the organizations that can help advance health care technology policy?
    - Can health care identify and define where the opportunities are?
    - Can the health care industry map/model and control the flow of 90% of the data in health care?

Conclusion

The “Advancing Health Care Using Automation: Opportunities with Modern Computing” workshop gathered diverse perspectives across multiple industries including engineering, human factors, technology, finance, robotics, aerospace, and aviation. At its conclusion, the workshop had identified the characteristics of workflows that make them well-suited for automation, health care workflows to consider for automation, and the levers that could advance workflow automation design and implementation. Participants called for accelerating efforts to pursue workflow automation to increase efficiency and reduce costs while driving improvements in outcomes and quality of care.

Appendixes

APPENDIX A: WORKSHOP AGENDA

Workshop Agenda
Advancing Health Care Using Automation: Opportunities with Modern Computing

Day 1: Monday, September 14, 2020

11:00 am – 11:20 am	**WELCOME and OPENING REMARKS**	**Don Rucker**, *MD, MBA, MS, National Coordinator, ONC*
11:20 am – 11:40 am	**KEYNOTE**	**Mary (Missy) Cummings**, *PhD, Professor, Duke University*
11:40 am – 11:55 am	**WORKSHOP OBJECTIVES and CHARGE FOR THE DAY**	**Teresa Zayas Cabán**, *PhD, Chief Scientist, ONC*
11:55 am – 12:15 pm	**PARTICIPANT REACTIONS and DISCUSSION**	**Anita Samarth**, *Workshop Lead, Clinovations Government + Health*
12:15 pm – 12:45 pm	**BREAK**	*ALL*
12:45 pm – 1:40 pm	**PANEL #1: AUTOMATION APPROACHES**	**Saira Haque**, *PhD, Moderator, RTI International* **Brian Denton**, *PhD, Panelist, University of Michigan* **Julie Shah**, *PhD, Panelist, Massachusetts Institute of Technology* **Matthew Yazdi**, *Panelist, J.P. Morgan*
1:40 pm – 2:35 pm	**PANEL #2: WORKFLOWS TO AUTOMATE**	**Raj Ratwani**, *PhD, Moderator, MedStar Health* **Keith Butler**, *PhD, MS, Panelist, Founding Member, BPM+* **Rasu Shrestha**, *MD, MBA, Panelist, Atrium Health* **Steven Waldren**, *MD, MS, Panelist, American Academy of Family Physicians*
2:35 pm – 2:45 pm	**BREAK-OUT CHARGE**	**Anita Samarth**

2:45 pm – 3:00 pm	**BREAK**	*ALL*
3:00 pm – 4:30 pm	**BREAK-OUTS**	*ALL*
4:30 pm – 4:45 pm	**BREAK**	*ALL*
4:45 pm – 5:45 pm	**DISCUSSION**	**Anita Samarth**
5:45 pm – 6:00 pm	**DAY 1 REVIEW and DAY 2 PREVIEW**	**Teresa Zayas Cabán**

Day 2: Tuesday, September 15, 2020

11:05 am – 11:20 am	**RECAP WORKFLOWS and CHARGE FOR THE DAY**	**Teresa Zayas Cabán**, *Chief Scientist, ONC*
11:20 am – 12:30 pm	**PANEL #3: KAISER PERMANENTE SPOTLIGHT**	**Lisa Caplan**, *MPH, Moderator, Kaiser Permanente* **Ash Tengshe**, *MS, Panelist, Kaiser Permanente* **Jack Zee**, *Panelist, Kaiser Permanente*
12:30 pm – 1:00 pm	**BREAK**	*ALL*
1:00 pm – 1:55 pm	**PANEL #4: MARKET AND POLICY LEVERS**	**Anita Samarth**, *Moderator, Clinovations Government + Health* **Grace Cordovano**, *PhD, BCPA, Panelist, Enlightening Results* **J. Marc Overhage**, *MD, PhD, Panelist, The Overhage Group* **Hoangmai Pham**, *MD, MPH, Panelist, The Institute for Exceptional Care*
1:55 pm – 2:05 pm	**BREAK-OUT CHARGE**	**Anita Samarth**
2:05 pm – 2:30 pm	**BREAK**	*ALL*
2:30 pm – 4:00 pm	**BREAK-OUTS**	*ALL*
4:00 pm – 4:15 pm	**BREAK**	*ALL*
4:15 pm – 5:15 pm	**REVIEW and DISCUSSION**	**Anita Samarth**
5:15 pm – 5:30 pm	**CLOSING**	**Teresa Zayas Cabán**

APPENDIX B: LIST OF PARTICIPANTS

Workshop List of Participants
Advancing Health Care Using Automation:
Opportunities with Modern Computing

Mary (Missy) Cummings, PhD, Professor, Duke University (Keynote)

Laura Adams, JD, Special Advisor, National Academy of Medicine; Catalyst, X4 Health; Oversight Council, Massachusetts Center for Health Information and Analysis

Keith Butler, PhD, MS, Founding Member, BPM+

Carol Cain, PhD, Executive Director, Clinical Information Services, The Permanente Federation and Kaiser Permanente Care Management Institute

Lauren Cheung, MD, Physician, Apple

Katherine Choi, MD, Director of Practice Transformation, Center for Health Care Innovation, University of Pennsylvania

Grace Cordovano, PhD, BCPA, Founder and President, Enlightening Results

Brian Denton, PhD, Professor and Chair, Department of Industrial and Operations Engineering, University of Michigan

Patricia Gabow, MD, Retired Chief Executive Officer, Denver Health

Mary Greene, MD, MBA, MPH, Director, Office of Burden Reduction & Health Informatics, Centers for Medicare & Medicaid Services

Thomas Goetz, MPH, Chief of Research, Good RX

Cherie Holmes-Henry, MeD, VP, Solutions, NextGen Healthcare, Former Chair, Electronic Health Records Association (EHRA)

Chris Howard, MBA, Founder and President, Medical Sensor Systems

J. Marc Overhage, MD, PhD, Principal, The Overhage Group

Fatima Paruk, MD, Chief Medical Information Officer at the US Health and Life Sciences Team, Microsoft

Emily S. Patterson, PhD, Associate Professor, School of Health and Rehabilitation Sciences, College of Medicine, The Ohio State University

Brian Pentland, PhD, Main Street Capital Partners Intellectual Capital Endowed Professor; Faculty Director, Center for Business and Social Analytics, Michigan State University

Hoangmai Pham, MD, MPH, President, Institute for Exceptional Care

Alvin Rajkomar, MD, Assistant Clinical Professor of Medicine, University of San Francisco Medical Center; and Product Manager, Google Health

Julie Shah, PhD, Associate Professor in the Department of Aeronautics and Astronautics, Massachusetts Institute of Technology

Rasu Shrestha, MD, MBA, Executive Vice President and Chief Strategy Officer, Atrium Health

Walter Suarez, MD, Executive Director, Health IT Strategy and Policy; Former Chair, National Committee on Vital and Health Statistics, Kaiser Permanente

Julie Sullivan, RN, Newton-Wellesley Hospital
Steven Waldren, MD, MS, Vice President & Chief Medical Informatics Officer, American Academy of Family Physicians

Steve Wretling, Chief Technology and Innovation Officer, Healthcare Information and Management Systems Society

Matthew Yazdi, Managing Director, Corporate & Investment Banking Technology, J.P. Morgan

Office of the National Coordinator for Health Information Technology Participants

Andrew Gettinger, MD, Chief Clinical Officer

Tracy H. Okubo, CSM, PMP, Sr. Program Analyst

Steven Posnack, MS, MHS, Deputy National Coordinator for Health Information Technology

Don Rucker, MD, MBA, MS, National Coordinator for Health Information Technology

Avinash Shanbhag, MS, Acting Executive Director, Office of Technology

Teresa Zayas Cabán, PhD, Chief Scientist

Workshop Break-out Facilitators

Edna Boone, Vice President, Clinovations Government + Health

Pascale Carayon, PhD, Director of the Wisconsin Institute for Healthcare Systems Engineering, University of Wisconsin - Madison

Moha Desai, Director, Clinovations Government + Health

Saira Haque, PhD, Senior Health Informaticist, RTI International

Matthew Holt, Co-founder, Health 2.0

Nicole Kemper, MPH, Director, Clinovations Government + Health

Raj Ratwani, PhD, Director, MedStar Health National Center for Human Factors in Healthcare

Anita Samarth, CEO, Clinovations Government + Health