Reengineering acute episodic and chronic care delivery: the Geisinger Health System experience

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Comparative effectiveness research (CER) represents an evolution in clinical decision-making research that allows for the study of heterogeneous groups of patients with complex diseases processes. It has foundations in decision science, reliability science, and health care policy research. Health care finance will increasingly rely on CER for guidance in the coming years. There is increasing awareness of the importance of decreasing unwarranted variation in health care delivery. In the past 7 years, Geisinger Health System has performed broad reengineering of its acute episodic and chronic care delivery models utilizing macrosystem-level application of CER principles. These provider-driven process initiatives have resulted in significant improvement across all segments of care delivery, improved patient outcomes, and notable cost containment. These programs have led to the creation of novel pricing models, and when “hardwired” throughout a care delivery system, they can lead to correct medical decision making by 100% of providers in all patient encounters. Neurosurgery as a specialty faces unique challenges and opportunities with respect to broad adoption and application of CER techniques.

Key Words • comparative effectiveness research • process improvement • best practices • care delivery reengineering • workflow redesign

In its broadest sense, CER can be considered a system for deciding between various diagnostic and treatment alternatives. Whereas traditional evidence-based medicine recommendations have their foundation in clinical trials and generally focus on questions of efficacy in homogeneous patient populations, CER places greater emphasis on diagnostic and therapeutic effectiveness. The significant difference in foundation and approach potentially better allows CER to investigate clinical decision-making questions in real-world conditions. As rapid-cycle performance improvement and process innovation become increasingly important, the ability to study relatively heterogeneous patient populations with often-complex disease processes gathers greater significance.

Conventional evidence-based medicine research in the form of randomized controlled trials, controlled studies, and meta-analyses has well-known limitations with respect to its ability to study conflicting variables and to assess the practice of medicine as it is actually practiced. One iteration of CER that can obviate some of these shortcomings is the concept of practice-based research and practical clinical trials. 

In 2005, the Geisinger Health System began multiple system-wide initiatives, across all segments of the

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provider environment, to reengineer the way it performs both acute episodic and chronic care delivery. These provider-driven efforts have been macrosystem adaptations and deployments of many of the foundational principles of CER. The programs in this portfolio have been adaptive and iterative projects that included significant continuous contributions from the fields of decision science, reliability science, information technology, and process improvement. The main goals have included integrating best practice–driven guidance into the daily workflow of real-world clinical decision making across heterogeneous groups of patients. In addition, these experiments have allowed for the implementation of novel pricing paradigms, such as warranties on care. Geisinger Health System has demonstrated that initiatives such as ProvenCare and ProvenHealth Navigator, when “hard-wired” into workflows and electronic health records, can result in reliable and correct care being delivered 100% of the time.\(^2,3,6,15,20,22\)

**ProvenCare and ProvenHealth Navigator**

The Geisinger Health System, founded in 1915, is an integrated, full-service spectrum quaternary health care system in central and northeastern Pennsylvania serving approximately 3 million people in 43 counties. The system consists of over 1000 group-practice physicians serving in 5 hospitals and over 65 community-practice locations. The system also operates an insurance company called the Geisinger Health Plan, with over 290,000 subscribers. The presence of the health plan allows for delivery-side research to be blended with payer-side investigations. Geisinger offers a wide range of residency and fellowship programs and has broad basic science, translational, and clinical research enterprises. The system has been a leader in health information technology, beginning implementation of an electronic health record in 1995.

There is increasing recognition of the negative patient, provider, and system impacts of unwarranted variation in health care delivery.\(^7,8\) It has been repeatedly demonstrated in both acute episodic care and chronic care that excessive use of unwarranted tests and treatment and underuse of necessary tests and treatment are commonplace and detrimental.\(^1,17,19\) In 2004, the leadership of Geisinger Health System proposed the challenging goal of redesigning systems of care to deliver the right care 100% of the time. The overarching goal of these initiatives has included reducing variation in diagnostic and therapeutic decision making by reliably delivering best practices rooted in evidence- or consensus-based care. The systems described incorporate a combination of standardization, error proofing, failure mode redesign, and effect analysis (see Fig. 1). Evaluation and redesign of daily workflows has occurred across all of the initiatives. These efforts have been provider driven, and patient engagement has been a central tenet throughout. A unifying theme across the portfolio of modules has been adaptive, iterative methodologies.

ProvenCare has been applied to acute states of disease, as in patients undergoing coronary artery bypass grafting (ProvenCare CABG\(^20\)) and patients needing percutaneous coronary intervention (ProvenCare PCI\(^20\)), as well as states of wellness such as pregnancy (ProvenCare Perinatal\(^9\)). Other programs have included modules geared toward total hip replacement, cataract surgery, and bariatric surgery. This methodology has also been applied to conditions that have both acute and chronic components and has now been applied outside of the Geisinger Health System to assess its scalability and applicability in a multiinstitutional effort (ProvenCare Lung Cancer\(^4\)). Additional important advanced medical home model experiments largely focused on outpatient, complex chronic conditions have also been implemented (ProvenHealth Navigator\(^9,22\)). The process surrounding ProvenCare CABG will be described in more detail as an example of the techniques used in improving reliability and decreasing variability of care.

For a variety of reasons well described elsewhere,\(^2,6\) coronary artery bypass grafting was a sound first choice for wide-ranging efforts at total process reengineering. These included the fact that there is a significant amount of existent Class I and Class IIa evidence in the relevant literature. The methods employed span the delivery system and include the microsystem of patient care delivery, the mesosystem of clinical leadership, and the macrosystem of executive leadership and finance. It has been observed that each implementation of ProvenCare has involved the redesign of distinct clinical and administrative microsystems into a novel mesosystem with altered leadership structures.\(^20\) The process in its most general sense involves 6 main steps (which have been occasionally altered according to the needs of the system in question) starting from engaging champions and ending with go-live production (See Fig. 2). This entire process can usually be completed in approximately 40 weeks.

Engaging champions involves identifying those mesosystem-level clinical and administrative personnel who will guide the process as leaders through to completion. It is possible that adaptations in management structure will be needed. Roles and expectations as they relate to the ProvenCare initiative must be clearly discussed. During this phase, initial meetings guided by process improvement specialists set the tone for institutional commitment to improvement.\(^20\) It is also important that these leaders be given adequate time, resources, and operational authority to carry the program through to fruition.

Compiling available evidence entails enlisting all microsystem-level clinical providers in collecting peer-reviewed literature, position papers by governing bodies, treatment guidelines, and so forth. Certainly, available Class I and Class IIa evidence should be compiled, but this process is not exclusive to those levels of evidence. This component is also guided by performance improvement specialists, and it has been observed in most implementations to take approximately 8 weeks. Frequent meetings are held, and at this stage they are typically inclusive of presented data and recommendations, rather than rendering any type of judgment on the validity or importance of presented information.

The next phase is the establishment of best practice measures (BPMs). This step lasts approximately 10 weeks and demands the participation of all physician and midlevel clinicians involved in the care of the patient.
population under study. In the case of ProvenCare CABG, all cardiac surgeons and many midlevel providers participated directly and frequently. This phase consists of making decisions on which components from the compiled evidence will be included as BPMs. When no clinical guidelines or Class I or Class IIa evidence is available to answer a certain question, then expert consensus among the provider group needs to be obtained for inclusion of a given BPM. All ProvenCare initiatives have required that 100% of the providers agree on the inclusion of 100% of the included BPMs. It is important that the defined BPMs be both measureable and actionable, and not ever be purely theoretical or unusable.20 This stage can obviously involve significant debate and discussion, with frequent meetings and an iterative process. ProvenCare CABG identified 40 distinct BPM elements of care across preadmission, perioperative, postoperative, discharge, and postdischarge patient states that were unanimously included.6 ProvenCare Perinatal decided upon 103 BPMs, which were deployed across 22 points of care.3 During this phase, process and performance improvement specialists thoroughly document existing workflow and patient flow patterns to understand how the reengineering of workflows may be best accomplished.

The key purpose of the process redesign phase is to reengineer existing workflows to systematically incorporate the defined BPMs. Throughout this segment, draft workflows are frequently disseminated for further review and discussion. Whenever possible, it is critically important to “hardwire” the defined processes and elements by incorporating them into the electronic health record, altering order sets and templates, and creating automatic

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**Fig. 1.** Diagrammatic representation of many of the reliability science and process improvement methodologies at the core of ProvenCare.

**Fig. 2.** Diagrammatic representation of the 6 main steps in the creation of a ProvenCare system.
actions so that 100% of the BPMs can be achieved in 100% of patient encounters. This phase employs significant involvement of information technology specialists and programmers. Wider implementations of ProvenCare have also consisted, in this step, of phased implementation and just-in-time education plans. Just-in-time education plans, timed for immediately prior to beta release, can have the benefit of recollection immediacy on the ability of microsystem-level providers to successfully implement the new workflow and BPMs.

Go-live beta generally proceeds for 8–10 weeks and involves intensive real-time data collection via the electronic health record, with rapid-cycle feedback provided to all segments of the team. This process of measurement and feedback assists with continued provider engagement. Performance improvement and information technology specialists are heavily involved in this process, as deficiencies and roadblocks to implementation are identified, for immediate repair of systems if needed. Full deployment follows in the go-live production phase. The process continues to be adaptive even after full deployment, with scheduled meetings to discuss improvements, new data, and potential BPMs as they emerge.

Not only is uniform provider participation necessary for this method to succeed, but patient engagement is also critical. Many of the ProvenCare modules have involved patients signing a detailed pact outlining their and their family’s important roles in care participation. In addition, extensive patient education, rehabilitation, and shared decision making have played prominent roles. We have found that a successful ProvenCare implementation involves all segments of the provider environment and all administrative levels of the system (see Fig. 3).

Results from many of the ProvenCare modules have been very encouraging. Measurement of outcomes in these studies involves not only assessing impact on clinical care, but also studying the degree of provider compliance with the defined BPMs. The goal of ProvenCare is always 100% provider participation in 100% of the BPM elements in all applicable patient encounters. ProvenCare CABG found that prior to the reengineering, 59% of patients were receiving all of the BPMs. Three months into the intervention, 100% of patients were receiving all of the elements. There was then a transient 3-month slip to 86% of patients receiving all 40 elements, and then the percentage increased back up to 100% of the patients receiving 100% of the elements for the entirety of the study. This study demonstrated a statistically significant improvement in the likelihood of a patient being discharged home, a 16% reduction in length of stay, and a 5.2% decrease in mean hospital charges. In addition, 30-day readmission rates fell by 15.5%.

ProvenCare Perinatal, which involved a large number of midlevel and physician practitioners across 22 varied points of care, had equally interesting results. After implantation and measurement of 103 unique BPMs, there was a statistically significant decrease in primary elective cesarian sections, a decreased rate of neonatal intensive care unit admissions, and significant and reliable implementation of diabetes management, preeclampsia, smoking cessation, and obesity care bundles.

Geisinger’s advanced medical home program has been named ProvenHealth Navigator. Detailed accounts of this program have been described elsewhere. This program focuses on the long-term outpatient care of complex, chronically ill patients. This module is largely geared toward patients over 70 years of age who have multiple medical conditions, including congestive heart failure, diabetes, and coronary artery disease, who may take a dozen or more medications. Efforts have focused on 5 core components: patient care (increased access, team-based care), population management (on-site point-of-care nurse case managers, remote monitoring within the home), value care systems (BPM-based use of radiology and laboratory services), quality outcomes (BPM programs and bundled care for chronic diseases), and novel reimbursement models (hybrid models including fee for service, pay for performance, and provider bonuses for performance in improvement initiatives). This program has led to significant decreases in hospitalization rates, decreased cost of care, and increased measurable patient satisfaction.

A unifying theme across these efforts has been a focus on the creation of novel reimbursement and health care finance initiatives. The existence of the Geisinger Health Plan has often allowed beta testing of these financial models within the Geisinger system. For example, ProvenCare CABG created single-package pricing applicable to patients undergoing elective coronary artery bypass grafting that included all preoperative, perioperative, and postoperative care (including such things as smoking cessation and cardiac rehabilitation). In addition, this single-package price included any and all rehospitalizations and care at a Geisinger facility for any related complications within a period of 90 days. The package pricing was achieved by an incremental increase in up-front bundled charges equivalent to 50% of the average cost of caring for complications in past experience. Essentially, this has the effect of transferring the financial risk for suboptimal care off of the involved payers and solely onto the system. Additional financial considerations include the fact that all members of the Geisinger physician group practice are employed by the system and up to 20% of total physician compensation can be linked to satisfaction participation in performance improvement initiatives. Broader future considerations include the possibility of lifetime warranties after treatment of certain conditions.

**Application of These Methods to Neurosurgery**

Neurosurgery as a specialty faces both significant challenges and significant opportunity in the area of process improvement. One significant hurdle relates to the relative paucity of available Level I and Level IIa data for many of the diagnostic and therapeutic decisions routinely faced by practicing neurosurgeons, although best practice guidelines are available for both traumatic brain injury and central nervous system metastasis. Given the high cost of imaging and interventions in neurological practice, the impact of CER in the field could be immense. Major limitations in the development of CER in neurological surgery stem from several sources. 1) Unlike

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cardiac surgery, neurosurgery has no fully developed large-scale databases such as the Society of Thoracic Surgeons’ General Thoracic Surgery Database. This database contains an extremely large number of surgical records and facilitates both quality improvement and comparative research initiatives. \(^4\),\(^12\).\(^13\) Similar efforts are underway in organized neurosurgery with the development of the National Neurosurgery Quality and Outcomes Database (N2QOD). 2) There are a multitude of pathologies and diversity of procedures performed by neurosurgeons that do not as easily lend themselves to comparison as do many of the procedures in cardiothoracic surgery. 3) Few neurosurgical residency programs emphasize health services research approaches or have clinicians formally trained with degrees such as the Master of Public Health (M.P.H.), where CER approaches are a core part of the curriculum. To address this shortage, partnerships with schools of public health and resident training in CER techniques are necessary.

National priority agendas for CER have included certain neurosurgical conditions.\(^18\) At Geisinger Health System, we have started wide-ranging formal process improvement initiatives focusing on epilepsy and spinal surgery. These are total process reengineering programs that will affect all aspects of care delivery including workflows, diagnostic and therapeutic care delivery, and financial design. As in previous initiatives, we will achieve 100% expert consensus on all defined BPMs and will expect 100% of the measures to be used in all patient encounters. We anticipate the creation of novel disruptive pricing models, particularly in the area of spinal surgery. Once these modules are satisfactorily developed and beta tested, we will strive for transparent multinstitutional collaboration on these projects whenever possible.

Conclusions

Comparative effectiveness research represents an evolution in the study of diagnostic and therapeutic decision making, which includes the ability to study diverse and heterogeneous populations of patients as treated in real-world conditions. While traditional evidence-based medicine investigations and randomized controlled trials will continue to play an important role in foundational medical literature, the ability to conduct value-based and quality-adjusted multivariate research will give CER an increasingly important role in the development of our specialty and of process improvement initiatives generally.

Geisinger Health System has engaged in macro-, meso-, and microsystem application of CER principles and techniques over 7 years of system-wide redesign of care delivery. These have been provider-driven initiatives that have had significant impacts on patient outcomes and appropriate cost containment. They have had the effect of markedly decreasing unwarranted variation in care delivery. It has been considered that a notable part of the observed benefit is likely due to the very act of having all involved providers go through the process itself (that is, compiling evidence and unanimously approving BPMs). This portfolio of initiatives and the developed incentive system has created an environment where process improvement work is a routine part of everyday work.\(^20\)

Neurosurgery as a field faces both significant challenges and significant opportunities in the arenas of CER and process improvement. Efforts such as the National Neurosurgery Quality and Outcomes Database represent promising new efforts of these types, and this database will require the support and participation of practicing neurosurgeons to become a repository of data that will enable CER and quality improvement in neurosurgical
procedures. Additional programs emphasizing shared data and transparency will likely provide the greatest amount of advancement. It is incumbent upon neurologi-
cal surgeons to continue to vigorously pursue provider-
driven, value-based care delivery solutions that provide
safe and affordable care. To aid in these efforts, organized
neurosurgery, neurosurgical postgraduate education, and
practicing neurosurgeons will need to evolve and embrace
CER methodology so that we can identify techniques to
provide the right care for our patients every time.

Disclosure

Dr. Steele is president and chief executive officer of the
Geisinger Health System.

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Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting of the article: Slotkin, Toms. Critically revising
the article: all authors. Reviewed submitted version of manuscript:
all authors. Approved the final version of the manuscript on behalf
of all authors: Slotkin. Study supervision: Toms.

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