The Colorado Collaborative for Nursing Research

Providing Trended Nurse-Sensitive Patient Outcome Data Across Entities

Karen H. Sousa, PhD, RN, FAAN
Blaine Reeder, PhD
Jessica Bondy, MSHA
Mustafa Ozkaynak, PhD
Jason Weiss, MEd

Nurse leaders lack timely access to trended electronic health record (EHR) data to drive decision making. Robust nurse-sensitive patient outcome data are difficult to locate in EHRs and largely absent across entities. The Colorado Collaborative for Nursing Research is currently testing a federated data system to get nurse leaders the information they need, when they need it.

The Colorado Collaborative for Nursing Research (CCNR)\(^1\) aims to meet the Institute of Medicine’s 2010 recommendation\(^2\) that nurses use data more effectively to maximize their healthcare impact. Launched jointly in 2013 by the University of Colorado (CU) College of Nursing and the chief nursing officers (CNOs) from several regional healthcare systems, the CCNR soon expanded to include representatives from national healthcare systems. The CCNR identifies and captures nurse-sensitive patient outcome data recorded in electronic health records (EHRs). The CCNR then provides the CNOs with timely, trended data visualization reports to drive decision making.

The CCNR was tasked by its CNO partners with the development of a system to access EHR data and establish a data trending mechanism that provides timely, actionable reports. In this article, the authors will describe how the CCNR is fulfilling this mandate by forming a federated data system (FDS) among participating healthcare systems. Through the FDS, the CCNR can deliver to nurse leaders the most helpful information retrieved from EHRs to support data-driven decisions.

The nursing profession has barely tapped the vast data reservoir of the EHR.\(^2\) Nurse leaders have reported a lack of access to usable nurse-sensitive patient outcome data, in general, and EHR data, in particular, to drive policy and validate nursing best practices (S. Pappas & C. Sanders, personal communication, January 15, 2013). Before the CCNR, nurse leaders had access to organization-specific financial and/or quarterly quality reports to support nursing practice and administrative decision making. These reports did not capture timely patient outcome data and thus allowed only a partial view of nursing’s healthcare impact. Nonetheless, nurse leaders based decisions (eg, about staffing workforce) predominantly on the content of these limited or nonbenchmarked documents. Therefore, to maximize nurse leadership efficacy, CCNR-partner nursing leaders have concluded that the nursing profession must (1) extract nurse-sensitive data that are already being collected in EHR, (2) get relevant data to nurse leaders and nurse clinicians as quickly as possible, and (3) use nurse-sensitive patient outcome data to track and evaluate nursing interventions.

**FDS Benefits for Nurse Leaders**

The ideal in today’s fast-paced healthcare environments is for nurse leaders to receive both financial
data and patient outcome data monthly, semimonthly, or even weekly on demand. Given the fluidity of the healthcare industry and the speed with which executives must act, timeliness of data is key. Providing nurse leaders with timely, trended nurse-sensitive patient outcome data is like giving them a streaming video feed of nursing care delivery support and patient response, an up-to-date and granular depiction of conditions at the point of service. Continuous assessment of trended nurse-sensitive patient outcomes allows for rapid response to any change in the patient outcome data trajectory and benchmarking with peers. The costs for CCNR trended data consist of (1) a 1-time membership fee, (2) a yearly participation fee, and (3) a case-by-case fee structure for user-requested advanced analytic services.

Application to Clinical Quality
Nurse leader participants in the CCNR FDS can identify and request data on any metric relevant to their respective facilities. For example, because change in patient pain scores from admission to discharge could represent quality of pain management (ie, a metric traditionally falling within the purview of nurses), a participating facility decides that the delta in pain scores from admission to discharge is a robust data point they would like to track by patient, by unit. Nursing informaticists at the CCNR and information technology (IT) professionals (1) initiate a data mapping process, (2) launch a query to capture 1st and last recorded pain scores in the facility’s EHR, and (3) enable the secure transfer of data to the CCNR Analytic Core at the CU College of Nursing. The CCNR analytic core team processes the data and generates a data visualization report for nurse leaders at the facility. Once nurse leadership signs off on the usefulness of the report, the query is automated through the FDS, setting up a recurring transfer of data and timely distribution of data visualizations. A sample visualization report (Figure 1) shows that trend lines differ among units caring for similar patient populations: unit A, on average, experiences a decrease in pain score throughout patient length of stay of 0.5 (on a scale from 0 to 10); unit B has average decreases of more than 2.0.

This disparity in patient outcomes might suggest a disparity in quality of pain management among units. In this example, a nurse scientist or clinician at the facility identified an evidence-based pain management intervention in place on unit B but that unit A had not operationalized. A quality improvement (QI) process was initiated to monitor the effectiveness of the intervention on unit A. Continuing CCNR FDS-enabled transfers of data and data visualization reports allow nurse leaders to monitor pain scores both pre-intervention and post-intervention on a week-by-week basis on unit A while continuing to monitor scores on unit B (Figure 2). On the basis of the timeliness of data produced through the FDS, the efficacy of the QI intervention is monitored in terms of weeks or months rather than quarters and years.

Application to Staffing
Additional iterations of the FDS can help determine optimal staffing levels, effect of staffing level changes, or benchmarking with peer organizations for similar scope-of-care comparisons. In summary, constantly trended patient outcome data customized to the demands of the healthcare facility give nurse leaders agility and responsiveness in addressing nursing care and/or organizational issues, as well as support for resource management.

![Figure 1. Sample CCNR FDS trending data report.](image-url)
**FDS Principles and Architecture**

The FDS process (1) eliminates the need to create, maintain, and secure access to central data repositories; (2) minimizes the anxiety associated with disclosing protected health information outside the data-owning entity; and (3) allows data holders to access, track, and authorize all data requests. In short, the FDS stakeholder can maintain participatory autonomy. Although the concept of FDS architecture is decades old, it has only recently been applied in biomedical informatics and clinical translational research. As opposed to a data warehouse, which requires forfeiture of data to a central authority, an FDS centralizes authority only to ensure data compatibility and consistency. In an FDS, primary control of data always remains with the participating health organizations (data use agreements and service contracts outline the terms and conditions to safeguard the data, liability from harm arising from the use of the data, and privacy rights associated with transfers of protected data). The FDS system allows for custom queries of EHRs while the data remain behind each participating facility’s firewall. Participating facilities can then review proposed queries and approve or reject query results before releasing data. Once a query is initially approved, subsequent pushes of the data relevant to this query, and only this query, can be automated. Each new independent query can also subsequently be automated. In this way, the FDS allows for maximum ease of use and minimum allocation of IT labor.

**The FDS Hub-and-Spoke Model**

The CCNR FDS use a hub-and-spoke model. A spoke-like pathway extends from a data processing/data harmonizing/data analysis hub to each participating facility. The participating facilities have no access to each other’s data. There are no pathways between facilities. Data are not co-mingled in moving on separate, secure pathways to the analysis hub. The hub does not have access to data from participating facilities. Each pathway leads from the hub to the locked front door (ie, firewall) of a participating facility. An envoy (ie, query) from the hub can come down the pathway, knock on the locked door, and slide a request for targeted information through a secure location in the door. If the facility has no interest in providing that information, it can ignore the request. However, if the participating facility sees a benefit in responding to the request—whether it would like to have these particular data processed and analyzed—then it can slide the data back through the secure system pathway (ie, a data push), and the data will be conveyed to the hub. The hub will never store the original data. The hub will aggregate the data only to allow individual participating facilities to see how their trended data compare with the aggregate trend line from all other participating facilities. Ultimately, a report in response to this specific request is sent back down the pathway. The report will have visualizations of (1) trended data from the participating facility and (2) the trend line from the participating facility versus aggregate trend line from all participating facilities. The data analysis report is delivered through a secure pathway. The raw data are then purged from the hub.

**PopMedNet as FDS Platform**

PopMedNet (PMN) (www.popmednet.org) is an open-source software system based on a federated data approach. It allows customized security and authentication based on data providers’ needs and preferences.
Moreover, PMN is data agnostic, allowing organizations to participate while still keeping data in their native, disparate formats. Data in existing formats, after they have been extracted from independent EHRs, can be mapped to previously agreed upon data models. Figure 3 illustrates the architecture and data flow of a PMN-based FDS that allows for aggregation, harmonization, and distribution of EHR data.

The numbered sequence in Figure 3 corresponds to the following steps:

1. An investigator initiates a query to the PMN query portal.
2. The query is sent to a PMN client outside the hospital firewall.
3. The approved query is run against a data warehouse behind the hospital firewall.
4. Results are sent to the PMN client.
5. Approved results are sent to the central server for processing and aggregation; query results are written to the database according to data use policy.
6. Aggregated results are sent to the investigator via PMN query portal.

**FDS General Features**

**Scalability**
Scalability is the ability of the system to be extensible in either function or capacity. New sites can be added; new database resources can be added to the existing site, or concurrent users can be added. Scalability is important in that a network is likely to be phased. Adding new hospitals to the CCNR FDS can expand the quantity of the data and support the integrity of the benchmarking process.

**Transparency**
Federated data system transparency implies that a user or potential user does not need to know system details to effectively use the system.

**Autonomy**
Autonomy refers to the degree of local control over a database resource and/or the degree of independence of the local system from the network. A hospital system can detach itself from the CCNR FDS at any point. Data owners maintain complete control of the use of their data at all times and can remove their data at any time.

**Security**
Security is a top priority when federating healthcare databases. An important security concern of federated databases is the development of federated security policies that can coexist with the operations of component databases. This requires a comprehensive approach that uses multiple layers of defense, such as passwords, biometrics, firewalls, secure sockets layers, and/or virtual private networks.

**Sustainability**
To be sustainable, a system must perform without major interruptions. Federated data system design factors maximize sustainability in meeting measurable goals, ensuring financial viability, and easing adaptation to new technical environments (ie, being flexible).

**Timeliness**
An FDS system supports timely information, assuming data marts are updated quickly. Queries can be run whenever the participating facility chooses. For a new query, a data model must be created, and a data mapping process must be completed. How long these steps take depends on the complexity of the query (ie, the number of data points requested). After the data have been mapped in the EHR and the query has been automated, a fixed, need-based turnaround time for user-driven analytics and data visualization reports can be established between the CCNR and the participating healthcare system.

Figure 3. CCNR federated data system architecture operationalized by PopMedNet.
Obstacles in Establishing a Data Network

Obstacles have been reported in data access and aggregation. Obstacles include (1) ethics based (i.e., related to the ethics of human subjects research and data privacy), (2) trust based (i.e., related to institutional variations in standards and practices), and/or (3) logistical (e.g., differences among institutions in computing environments and information systems, the need for data standardization and validation, and organization-by-organization variation in contracting policies and procedures). Before establishment of the CCNR data network, these obstacles were evaluated. Colorado Collaborative for Nursing Research data network designers used FDS principles, architecture, and general features to address and obviate these potential obstacles.

Conclusions

The FDS approach has great potential for capturing nurse-sensitive patient outcomes and providing benchmarking across entities. The FDS facilitates participation of partners through the use of data in existing formats rather than requiring changes in workflow or data collection and by providing for the setup of recurring queries/data transfers. Both of these features make the burden of FDS participation minimal. Before establishment of the CCNR FDS, this approach to EHR data mining had not been available for nurse-sensitive outcome data across entities. Without appropriate and timely data, nurse leaders cannot make optimal care delivery and financial decisions. The CCNR FDS aims to meet this demand by (1) extracting nursing-specific data from the proprietary EHR systems of multiple stakeholders; (2) importing, harmonizing, and processing those data; and (3) returning high-quality nursing-centered analytics to acute care facilities in near real time to inform the decisions and best practices of nurse leaders and nurse clinicians. The CCNR FDS may be a model for nurse leaders to consider as they collaborate to use EHR data effectively.

Acknowledgments

We want to acknowledge our original chief nurse executive partners: Kelly M. Johnson, PhD, RN, NEA-BC, Vice President, Patient Care Services, and Chief Nursing Officer, Stanford Children’s Health and Lucile Packard Children’s Hospital Stanford; Sharon H. Pappas, PhD, RN, NEA-BC, FAAN, Chief Nurse Executive, Emory Healthcare; and Carolyn L. Sanders, PhD, RN, NEA-BC, FACHE, Chief Nursing Executive, UC Health, and Chief Nursing Officer and Vice President, Patient Services, University of Colorado Hospital.

References