Data Integration in Health Care

8

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Health data integration is considered a key component and, in some cases, a pre-requisite in nearly every systematic attempt to achieve integrated care. In the context of health care, data integration is a complex process of combining multiple types of data from different sources into a single infrastructure, allowing multiple levels of users to access, edit, and contribute to an electronic record of health services (EHRs). The types of data integration that are performed depend on the quality, quantity, and capability of the service performing the integration as well as the needs of the current and future users of the new framework (Johnson et al. 2008). In the following chapter we describe six basic types of data integration, the pathways by which data integration facilitates integrated care, the main players of health care data integration, and key challenges to integrating data.

8.1 Types of Data Integration

8.1.1 Horizontal Integration

Horizontal data integration occurs when the data segments being combined originate from similar kinds of sources. Two examples are combining data from multiple nursing shifts in an inpatient setting (Flaks-Manov et al. 2015) or from various community health care providers within a single clinic (Balicer et al. 2014).

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V. Amelung et al. (eds.), *Handbook Integrated Care*,
DOI 10.1007/978-3-319-56103-5_8

Horizontally integrated data is inherently non-hierarchical and there is no inherent weight or priority given to the different sources of data. The main obstacle to horizontal integration is combining the data in a way that all the data is consistently represented: one source may measure and record weight in kilograms (kgs) while another, in pounds (lbs) and one may not weigh at all, resulting in missing values. We delve deeper into data consistency later in the chapter when we discuss data quality.

8.1.2 Vertical Integration

Vertical data integration occurs when data from different types of sources are combined into one database. For example, vertical data integration would combine the information documented by a nurse who performs weekly home visits with the information recorded by a physician who performs a quarterly physician review of a diabetic treatment regimen. This type of integration requires a thoughtful organization of how to nest and correlate the findings from each assessment, which contains a hierarchical provider structure. Sources are likely to serve both independent and yet interrelated goals; A nurse may monitor patient medication compliance in a weekly visit which may drive a physician to change treatment goals at the subsequent review. Alternatively, ranking or prioritizing a single diagnosis when a patient has been seen by multiple general practitioners and referred to varying sub-specialists creates challenges when data managers have to apply subjective interpretations to previously objective documentation.

8.1.3 Historical Integration

The merging of patient health records from multiple systems and of different formats (including paper charts) often requires additional processing or review in order to reconcile basic or summary information to serve as a reference for future use. This manual compilation of data can be tedious, costly and full of error, all of which are reasons EHRs were not adopted quickly (Evans 2016).

8.1.4 Longitudinal Integration

The data captured on a patient is a dynamic process over time; As certain conditions resolve and others may develop. Therefore, health care data integration requires flexibility to allow for new entries and new types of entries. Furthermore, as our understanding and management of treatment advances over time, we are increasingly in need of the new methods of capturing and storing data that can still be merged consistently with less precise information.

8.1.5 Cross-Indexing Integration

The ability to relate an individual's medical records with their family member's current medical care or medical history presents a unique opportunity to expand the detail present and accessible across multiple generations as well as multiple exposures (living within the household of smokers identifies ones as exposed to second-hand smoke or to other health risks increased by a shared living environment, such as type 2 diabetes). Such a level of data integration requires a cross-indexing mechanism to ensure that multiple records can be updated simultaneously.

8.1.6 Alternative Sources

Patient reported outcomes, social media, biomonitoring data from various sensors, genome sequencing, and even open chart models are increasingly becoming relevant sources of data for holistic processing of patient health records (Frey et al. 2015). Data integration that includes these types of data can offer new dimensions of insight.

8.2 The Importance of Data Integration

Data integration is a key facilitator of integrated people-centred care. Un-integrated data strongly hinders any attempt to integrate the provision of care and to empower patients. Decision-making processes that occur in isolation of known, documented, and managed data are inherently problematic, from both the managerial and legal standpoint. While not all types of data will necessarily contribute to a given clinical decision, such as initiation of a therapy or transfer to an assisted living facility, an integrated system provides critical support for decisions that weigh the short- and long-term implications of a change in care to patient experience.

Recent studies have shown that it is beneficial for patient records be readily accessible not only to the care provider but also to patients themselves (Esch et al. 2016; Sustains 2014). Some organizations have taken this principle to the most extreme and adopted an open-chart system that allows for co-creation and management of EHRs by providers, care-givers, and patients. One recent study on such a system (Esch et al. 2016) found a direct relationship between "open notes" health records and improved medication adherence, self-care, and a high level of patient empowerment. This example of data integration demonstrates the importance of a thorough understanding of the quality and quantity of data that needs to be managed in a fully integrated record.

8.3 Impact of Data Integration

In addition to serving the needs of the patients and providers, data integration has a potential measurable impact on two key components of a high quality health care delivery system: reducing waste and improving decision-making capacity.

8.3.1 Types of Waste That Can Be Reduced with Data Integration

8.3.1.1 Repeat Testing

One of the most commonly cited examples of the beneficial impacts of data integration is the ability to reduce repeat testing (Menachemi and Collum 2011). Patients who undergo testing at one institution, if upgraded to another more acute facility, do not necessarily have to undergo repeat testing for the purposes of internal or external validation.

8.3.1.2 Manual Integration of Data

In the absence of data integration, each provider that sees a patient may find themselves entering data into an unstructured format the reports symptoms, laboratory findings, mediation list, medical history, and additional key components of a medical history. This type of complete history and physical exam, which may be instructive as an exercise for the individual physician, is repetitive and prone to error when applied multiple times at multiple facilities.

8.3.1.3 Informal Reports

The sharing of information between providers may occur informally, particularly if there is no avenue for routine data integration. Specifically, there may be telephone or conversational discussions regarding patient care and management that are not readily documented for verification and for future reference which is important if there are follow up questions to the decisions made during the transfer of care. While it is highly likely that these types of integration will continue and even potentially increase in frequency, it is, nonetheless, important to provide a platform for their inclusion in health records so they are not lost or repeated unnecessarily.

8.3.2 Improving Decision-Making Capacity

8.3.2.1 Individual Level

Patient-centred care requires not only the ability of the provider to consider the consequences of their decision-making on the daily management on the part of the patient but also the ability of the patient to determine and direct the priorities in his or her own management. Data integration creates a streamlined library from which a patient can review and respond to multiple aspects of their medical history and treatment pathways in order to play a proactive role in a conversation regarding his or her health.

8.3.2.2 Provider Level

Logic follows that providers who can actively and easily access complete medical records are more likely to prevent issues resulting from drug-interactions or allergic reactions. Furthermore, using integrated medical records, they may be able to base their clinical decision-making processes on the most up-to-date information, which is important if a patient is unable to provide detailed history.

8.3.2.3 Policy Level

Both provider and payer organizations benefit from the collective input of multiple parties when reviewing their management of individual patients and of larger populations (at the clinic or district level). At the clinic level, data integration allows for real-time monitoring and evaluation of interventions and the quality of service delivery. At the district level, data integration supports the ability to compare the needs and outcome of various clinics, resulting in the ability to focus on granular information, such as practice variation, needs-based planning, and quality improvement measures. Furthermore, the ability for an umbrella organization to proactively distribute resources (vaccines, nursing educators, and social workers) can be supported by the demonstrated and predicted needs within and between communities.

8.3.2.4 International Level

Standards of care, as supported by randomized control trials and large observational studies and driven by a panel of experts and policy makers, have much to gain from all types and all levels of data integration (Bloomrosen and Detmer 2010). When organizations are able to integrate the health care utilization and practice patterns on a large scale, they are able to predict future needs, identify trends, and isolate previously untapped potentials for interventions such as practice variation and hot spots of disease or highly effective delivery of care. Ultimately, comparisons of local findings are best able to have global significance when they can be directly compared to similar system among various health-care and resources utilization outcomes.

8.4 Key Challenges in Integrating Data

The main challenges that concern advocates of data integration include access to, quality of, and ongoing monitoring of integrated data (Lampsas et al. 2002).

8.4.1 Access and Privacy

Designing a system to provide meaningful access to data can range from simple access, which is open to everyone to complicated, in which different levels of access are required for each part of an EHR, determined by the privacy needs of the patient and the differing levels of responsibility multiple different decision-makers.

The majority of systems find themselves with a combination of access levels, where the majority of integrated data is available to the patient and providers, with some key sensitive material flagged as requiring additional clearance (infectious disease data, for example). Some may argue that providers must be able to access all types of data, such as a patient's psychiatric history when assessing medication adherence, and others argue that certain types of health records are at risk for a breach of privacy and at worst embarrassing and at best irrelevant, such as revealing the occurrence of a treated sexually transmitted disease on an asthma treatment plan several decades later. However, the decision-making power rarely rests with one person and often requires a case-by-case review. Patient-driven input is increasingly suggested as an important contribution in order to maximize the utility of a patient medical record (Sacchi et al. 2015).

8.4.2 Security

Data security is a challenge for all large datasets and is important for maintenance of both privacy and accuracy of the data stored. Data security issues may arise when there are outside forces seeking to access the data warehouse, but more frequently can arise when there is an unintentional breach in data security by a provider who is not sufficiently attentive to the needs of security. While the primary responsibility for the maintenance of a data security system rests on the central organization, any person with access to the data has the ability to compromise the data security, therefore their use and modification of the data should be monitored accordingly.

8.4.3 Quality

The overall quality of integrated data is likely to be no greater than that of the lowest quality component. Integrated data is inherently dependent on its components, and a marked difference in quality in one component can have a substantial impact on the interpretation of other components.

8.4.3.1 Quality Assessment

Quality assessment may refer to both routine and random chart reviews in order to understand the extent to which data is inconsistent, contradictory, or nonsensical (Scheurwegs et al. 2015). Consistent data deliver the same message regardless of the format. Two examples of varying data formats are structured (coded) and unstructured (uncoded) data. Seemingly contradictory data can present due to various health care providers documenting different assessments. Adopting a blanket hierarchical nature of data quality would prevent the documentation of nuances that may later serve the patients treatment. For example, a patient may report in a brief interaction to physician that he is overall experiencing “no pain,” but to a nurse may reveal “reduced pain” or a “change in pain.” These reports are not necessarily contradictory but, nonetheless, create a challenge to maintaining within an integrated system. Finally, the integration of data increases the risk for the presence nonsensical raw data due to the typographical errors in coding or transferring of data from one system to another. Each of these factors requires a different approach to minimize their impact on the overall quality of the data.

8.4.3.2 Quality Control

Quality control outlines the distinct steps undergone by a managing body to review and revise integrated data based on a quality assessment. Quality control may be a tedious process and may uncover minor and significant errors at similar rates that are difficult to distinguish. However, a perception of a high level of quality control is critical to achieve successful data integration because the extent at which patients and providers will use the data for their decision-making is inherently dependent on their perception of the quality of available data.

8.4.4 Tracking Use of Integrated Data

Monitoring the use of integrated data is the first step to evaluating its impact and limitations.

8.4.4.1 Providers

While the majority of users are likely to be the health care providers, the extent to which they create versus utilize data in an integrated system is an important marker in the ongoing monitoring process. Logic follows that the more accessibility a provider has to their system, the more likely he or she will use the clinical decision-making process. For example, providers who lack the ability to review, modify, and incorporate patient-reported data are probably less likely to invest in reviewing or applying it to their decision making process. Furthermore, once fully situated, the use of an integrated system could reduce a provider’s time spent recording and reviewing clinical data.

8.4.4.2 Patients

Use of medical records by a patient might be an excellent barometer as to whether the relevant types of information are being stored and catalogued in a useful manner. Patient-centred care, which focuses on employing patients as driving factor in determining the integration of services, should substantially inform the characteristics of data that are being created through the use in the ongoing delivery of care. When patients are found to be actively accessing and responding to their providers’ notes and messages, it is more likely that providers are capturing relevant information to the goals of their patients (Evans 2016).

8.4.4.3 Policy Makers

Policy makers are likely to be less concerned about the detailed interactions between social work and home nursing care, and more likely to be concerned about the overall coordination of care between various levels of providers and the various levels of acuity. Transfers to long term facilities or discharges from lengthy inpatient stays are transition points of high concern to policy makers that have a high likelihood of benefiting from data integration. The extent to which the adoption of a comprehensive chart review and medication reconciliation is indeed a reality in practice upon transfer between facilities, and whether it has a successful and meaningful impact, must be assessed through strategic planned review between the institutions (MacLeod 2015).

8.4.4.4 Insurers

While patient privacy must be maintained and ownership is ultimately shared in various combinations between the creators of the data (i.e., patient, provider, insurer), policies which unduly limit data dissemination between parties involved in care provision and quality assessments can diminish the impact of integrated data on the delivery of care. When an insurer's priority is to know that the correct treatment is being delivered to the right patient, integrated data can provide a strong source for support in the decision-making processes for fee-for-service, bundled payments, and pay-for-performance, alike. The combination of documentation of services along with the documentation of provider reports and justification for those services can ultimately benefit not only the patient but also the overall efficiency of the health care system.

8.5 Summary

Health care data integration is a complex task, but is considered a cornerstone of every systematic attempt to achieve integrated patient care. It requires detailed planning and ongoing assessment to ensure accurate and effective coordination of information. Ultimately, data integration has the potential to provide multiple stakeholders with critical, timely, and detailed information for short- and long-term decision-making, documentation, and it supports attempts to achieve structural and functional health care coordination and integration.

References

Balicer, R. D., Shadmi, E., & Israeli, A. (2014). Interventions for reducing readmissions – are we barking up the right tree? *Israel Journal of Health Policy Research, 2*, 2.

Bloomrosen, M., & Detmer, D. E. (2010). Informatics, evidence-based care, and research; implications for national policy: A report of an American Medical Informatics Association health policy conference. *Journal of the American Medical Informatics Association, 17*(2), 115–123. doi:10.1136/jamia.2009.001370.

Esch, T., Mejilla, R., Anselmo, M., Podtschaske, B., Delbanco, T., & Walker, J. (2016). Engaging patients through open notes: An evaluation using mixed methods. *BMJ Open, 6*(1), e010034. doi:10.1136/bmjopen-2015-010034.

Evans, R. S. (2016). Electronic health records: Then, now, and in the future. *IMIA Yearbook of Medical Informatics, Suppl 1*, S48–S61.

Flaks-Manov, N., Shadmi, E., Hoshen, M., & Balicer, R. D. (2015). Health information exchange systems and length of stay in readmissions to a different hospital. *Journal of Hospital Medicine*. doi:10.1002/jhm.2535.

Frey, L. J., Sward, K. A., Newth, C. J., Khemani, R. G., Cryer, M. E., Thelen, J. L., Enriquez, R., Shaoyu, S., Pollack, M. M., Harrison, R. E., Meert, K. L., Berg, R. A., Wessel, D. L., Shanley, T. P., Dalton, H., Carcillo, J., Jenkins, T. L., & Dean, J. M. (2015). Virtualization of open-source secure web services to support data exchange in a pediatric critical care research network. *Journal of the American Medical Informatics Association, 22*(6), 1271–1276. doi:10.1093/jamia/ocv009. Epub 2015 Mar 21.

Johnson, P. J., Blewett, L. A., Ruggles, S., Davern, M. E., & King, M. L. (2008). Four decades of population health data: The integrated health interview series as an epidemiologic resource. *Epidemiology, 19*(6), 872–875.

Lampsas, P., Vidalis, I., Papanikolaou, C., & Vagelatos, A. (2002). Implementation and integration of regional health care data networks in the Hellenic National Health Service. *Journal of Medical Internet Research, 4*(3), E20.

MacLeod, H. (2015). Local health integration networks: Build on their purpose. *Health Management Forum, 28*(6), 242–246. doi:10.1177/0840470415600127. Epub 2015 Sep 28. Review.

Menachemi, N., & Collum, T. H. (2011). Benefits and drawbacks of electronic health record systems. *Risk Management and Healthcare Policy, 4*, 47–55. doi:10.2147/RMHP.S12985.

Sacchi, L., Lanzola, G., Viani, N., & Quaglini, S. (2015). Personalization and patient involvement in decision support systems: Current trends. *IMIA Yearbook of Medical Informatics, 10*, 106–118.

Scheurwegs, E., Luyckx, K., Luyten, L., Daelemans, W., & Van den Bulcke, T. (2015). Data integration of structured and unstructured sources for assigning clinical codes to patient stays. *Journal of the American Medical Informatics Association, 23*, e11–e19.

Sustains. (2014, May 14). *Patient access to their health records becomes a reality in Europe*. Press Releases. European Commission. Retrieved October 30, 2016, from http://www.sustainsproject.eu/pressreleases?lang=sv