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# Semantic Interoperability

Unlocking the Potential of  
Digital Health Information

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PREPARED BY

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**360°  
CLINICAL  
INTELLIGENCE**

## EXECUTIVE SUMMARY

Interoperability, or the ability to use digital health information across diverse care settings and clinical software, will significantly improve care delivery in the United States. While much progress on interoperability has been made in the past decade, full medical summaries do not attain “semantic interoperability” or information exchange with meaning. In this whitepaper, we explore key initiatives necessary for achieving interoperable care summaries and steps that can unlock the potential of digital health information.

## INTRODUCTION

In recent months, public attention to the challenge of interoperable medical information has increased. The issue has made its way, from local clinics to regional health systems, to the halls of the United States Congress. Senator Patty Murray, ranking member on the Health, Education, Labor and Pensions committee, expressed the pressing need for “systems developed by different vendors and used by different doctors to actually speak to each other.”<sup>1</sup> It frustrates patients and politicians alike that medical information isn’t readily shared, but the obstacles to interoperability are complex and require clear definition.

Interoperability is often considered the ability to electronically share information. Today, there are defined pockets of the US healthcare system that are widely interoperable. Every time a physician or hospital bills a payer, electronic information is exchanged during authorization, claim submission and reimbursement. When a physician creates a medication order, e-prescribing has largely eliminated the use of paper prescription pads. While complex, these processes have clear use cases and are largely automated throughout the United States.

When we approach the larger desire of patients and providers to exchange rich care summaries, however, interoperability complaints arise. The need for such information exchange is clear. The average Medicare patient in the United States will have seen over 28 different physicians for their medical care.<sup>2</sup> Consequently, their medical data are fragmented among a series of electronic health records (EHRs) and health organizations. Most patients do not maintain a personal health record or comprehensive medical history of all relevant information; instead they rely on a combination of memory, prescriptions, family members and piecemeal notes.

Constructing a longitudinal record for all patients and their clinicians would both help prevent medical errors and reduce care redundancy in the United States.<sup>3</sup>

## THE STEPS TO INTEROPERABILITY

So let’s walk through the necessary steps to construct a longitudinal and digital medical record:

1. Medical information must be digitally recorded
2. Electronic Health Records (EHRs) must be capable of automatically sending this digital information
3. Data receivers must be capable of understanding and integrating information from multiple records

*“Systems developed by different vendors and used by different doctors [need] to actually speak to each other.”*

—US SENATOR MURRAY

For the first step of creating digital and structured medical information, the clearest requirement is widespread EHR adoption. While estimates vary, adoption of EHRs among US hospitals is considered to be above 95% and between 80-90% for office-based physicians, where this percentage continues to grow.<sup>4</sup> While not complete, that provides a reasonable baseline for the digitization of medical records in the United States.

In the second step, there is a need for EHRs to send this digital information. This is often referred to as *technical interoperability*. Given the laws governing healthcare data privacy and security, *technical interoperability* is more complex than in other industries. Not all people, clinicians, or organizations who request medical information are entitled to its access. Secure transmissions require technical safeguards and clear audit trail of whom has accessed a patient's medical record. A decade ago, *technical interoperability* was the real challenge for healthcare. At that time, EHRs weren't often connected to IT systems to transmit medical data, as healthcare organizations routinely used paper and fax machines.<sup>5</sup> Today, most health organizations can send information about patients through a regional health information exchange (HIE), a secure email system, or provide access via a patient portal. These represent hallmarks of *technical interoperability*. Today a majority of physicians and hospitals can transmit care summaries electronically and automatically. *Technical interoperability* still eludes some providers, such as home health practices, but significant progress has been made.

The final step is the hardest. This step deals with establishing *semantic interoperability*. Today's website browsers provide a prime example of how this works. When you go to amazon.com and search for aspirin, your browser downloads and processes information so that you can see, purchase and ship the aspirin without having to think much about the technical details of how it all works. Your system, the browser, and another system, Amazon's web server, work together seamlessly to reliably transmit product, shipping and payment information with shared context.

To extend this metaphor to healthcare, the goal of *semantic interoperability* would be to allow for easy integration, visualization and analysis of patient data, independent of the organizations or EHR systems where it resides.

A more formal definition of *semantic interoperability* has been established for medical data as "the ability to import utterances from another computer without prior negotiation, and have your decision support, data queries and business rules continue to work reliably against these utterances."<sup>6</sup> Practically speaking, patients and clinicians should be able to integrate and use medical information after it is sent for a variety of purposes with reasonable confidence in its meaning. This step is frequently lacking in health information exchange and has been referred to as a "semantic gap" due the complexity of medicine.<sup>7</sup>

## SEMANTIC INTEROPERABILITY IN HEALTHCARE

*Semantic interoperability* works for finance and online ordering. This is due, in part, to the simplicity and certainty of the concepts. Banks can reliably debit and credit funds worldwide since money is a quantifiable resource and the transaction information is highly structured. Medicine is more complicated. Two physicians may not agree on a diagnosis of a patient, and even if they do, they may document that problem in vastly different ways. Documenting that a patient has "heart failure" can be done using 91 different codes using terminologies like SNOMED, ICD-9 and ICD-10, according to national measures related to care quality. In healthcare, clinicians routinely deal with terminologies that contain many thousand codes, many of which are duplicative or have overlapping meaning. In addition, some of the most important aspects of medical care may be captured in unstructured narrative, which is unlike other industries.

“We won’t achieve semantic interoperability by expecting millions of physicians and nurses to magically standardize terminologies, measurements and workflows.”

—CTO JOHN D’AMORE, MS

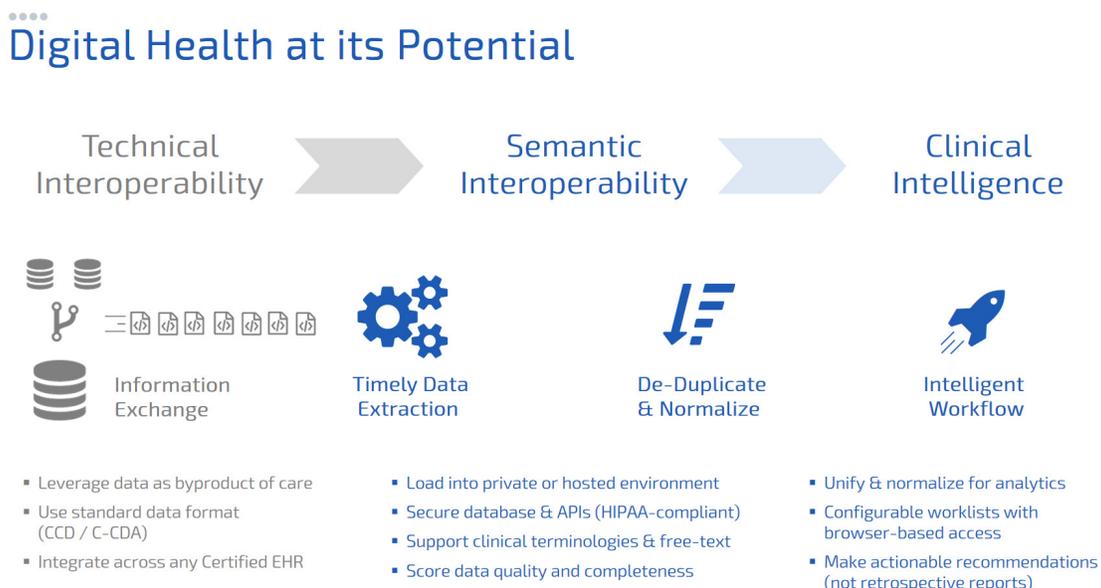
For medical information that is quantifiable, clinicians often choose different ways to measure. A patient’s temperature may be measured in Fahrenheit or Celsius. While converting temperature is easy, some lab results can be more challenging. Over 4,000 clinical laboratories exist in the United States and use a wide array of methods, units of measure and reference ranges for individual components.<sup>8</sup> Diameter Health has documented dozens of ways that even relatively straight forward lab results can be recorded.

Finally, there are more clinicians who generate medical data than there are banks or online retailers. Federal initiatives aimed at the adoption of health information technology, such as Meaningful Use, have reduced some of the variation between clinicians by designating preferred vocabularies, but adherence to these kind of government initiatives is not

universal. John D’Amore, Chief Technology Officer of Diameter Health summarizes the issue as follows: “Data variation during exchange is a reflection of how clinicians document care. We won’t achieve semantic interoperability by expecting millions of physicians and nurses to magically standardize terminologies, measurements and workflows. Instead we should look to intelligent technology.”

## DIGITAL HEALTH AT ITS POTENTIAL

To create longitudinal patient records across the fragmented electronic health record industry, medical content must be intelligently normalized regardless of source. Otherwise, any summary will be highly duplicative and possibly contain contradictory information for patient and clinician use. That need exists regardless of which specific standard is used to extract the information. Many vendors help in this process, but Diameter Health is a leader in this field with extensive experience normalizing data from documents in use today, such as the Consolidated Clinical Document Architecture (C-CDA).<sup>9</sup> Our team helped author the HL7 standard and has worked with the leading electronic health record vendors in how they adopt it.<sup>10</sup> Transformation of digital clinical data through normalization, classification, visualization and evidence-based medicine is critical to achieving semantic interoperability. At Diameter Health, we call the result of such transformation *clinical intelligence*, turning raw medical data into the prospective, actionable information as illustrated below:



While the value of a normalized, longitudinal medical record for patients and clinicians is enormous, the impact for medical applications will be even greater. In the New England Journal of Medicine article *No Small Change for the Health Information Economy*, Dr. Ken Mandl states “the platform approach to software design can be used to create and sustain an extensible ecosystem of applications and to stimulate a market for competition on value and price.”<sup>11</sup> Such applications become increasingly important as reimbursement shifts from fee-for-service to patient outcomes.

Today, using clinical data from C-CDA documents, Diameter Health has developed applications to predict patient readmission, mortality and fall risk (DH Predict), and scan medical records for the omission of relevant medical diagnoses (DH Envision). Such applications provide direct value to health systems and leverage the investments in technical interoperability made by health information exchanges. Eventually, healthcare will be populated with diverse applications to improve care, but this will only be possible by establishing the *semantic interoperability*, the foundation of this vibrant ecosystem of medical applications.<sup>11,12</sup>

## REAL WORLD APPLICATION

Putting together a clear definition of *semantic interoperability* with the need for *clinical intelligence*, we have a framework for creating longitudinal medical records and medical applications to improve care. Executing on this vision in the real-world with millions of records requires the right tools. Major clinical terminologies, such as SNOMED, ICD-9, ICD-10, RxNorm and LOINC, must be cross-referenced and consolidated. Free text, which remains prevalent, must be integrated into the information flow and mapped to relevant clinical concepts. Furthermore, these processes must use information produced as a byproduct of care rather than asking over-tasked clinicians for manual editing and revision.

An example of this complexity is illustrated below with excerpts from C-CDA documents. Diameter Health normalizes these various documentations of a patient problems and organizes such information for downstream population health applications.

### #1 C-CDA Problem Observation Using SNOMED

```
<observation classCode="OBS" moodCode="EVN" negationInd="false">
<templateId root="2.16.840.1.113883.10.20.22.4.4" assigningAuthorityName="C-CDA Problem Observation" />
<...several required XML elements skipped...>
<value code="73211009" displayName="Diabetes Mellitus (disorder)" codeSystem="2.16.840.1.113883.6.96"
codeSystemName="SNOMED CT" />
</observation>
```

### #2 C-CDA Problem Observation Using ICD-9 (with wrong SNOMED code)

```
<observation classCode="OBS" moodCode="EVN" negationInd="false">
<templateId root="2.16.840.1.113883.10.20.22.4.4" assigningAuthorityName="C-CDA Problem Observation" />
<...several required XML elements skipped...>
<value code="55607006" displayName="Problem" codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT">
<translation code="250" displayName="Diabetes mellitus" codeSystem="2.16.840.1.113883.6.103"
codeSystemName="ICD-9" />
</value>
</observation>
```

### #3 C-CDA Problem Observation with Free-Text

```
<observation classCode="OBS" moodCode="EVN" negationInd="false">
<templateId root="2.16.840.1.113883.10.20.22.4.4" assigningAuthorityName="C-CDA Problem Observation" />
<...several required XML elements skipped...>
<value nullFlavor="UNK">
<originalText>
DM2 (Shorthand free-text for Type 2 Diabetes)
</originalText>
</value>
</observation>
```

Single Medical  
Concept (Diabetes)

Diameter Health has industry-leading experience working with both HIEs and leading health systems to normalize medical information using the above standards and associated terminologies. We would welcome the opportunity to highlight our expertise and explore how we can build semantically interoperable documents with your organization.

## ABOUT DIAMETER HEALTH

Diameter Health is transforming healthcare through actionable and predictive clinical intelligence. The company develops software solutions built on interoperability standards. Our clinical analytics normalize and detect clinical meaning from the wealth of data that is often “trapped” in Electronic Health Records (EHRs).

Diameter Health offers a range of solutions that leverage EHR technology and Meaningful Use data. We assess patient risk, integrate information across practices and optimize resource utilization. Our software makes the intelligent use of data easier, so organizations can focus their resources on delivering superior care.

**DH Fusion:** This is the engine of the Diameter Health platform. DH Fusion parses, normalizes, classifies and interprets a broad array of clinical data—the first step in enabling powerful and timely analytics. DH Fusion unifies disparate data and unlocks the power of knowledge normally confined in EHR information silos. This enables organizations to communicate more effectively across the continuum of care and leverage their significant investments in EHR technologies to increase productivity and improve patient outcomes.

*DH Fusion allows you to accomplish the third step, as described on page 2 above, to achieving interoperability, and which ensures that the data receivers are capable of understanding and integrating information from multiple records.*

**CCD Analyzer:** CCD Analyzer helps institutions enhance the clinical document exchange experience between clinicians and consumers. It can help provide better care transitions by monitoring clinical document richness, quality, and consistency over time.

CCD Analyzer provides quality assurance of your Continuity of Care Documents (CCDs). CCD Analyzer is a flexible tool which can be used for processing individual or multiple documents.

With 200+ rules, it detects dimensions of document completeness, syntax and consistency across key sections of CCDs. For completeness, it validates that the expected sections are included and complete. For syntax, it determines if the document is structured correctly, and if the correct terminologies are used. CCD Analyzer currently supports all standardized clinical terminologies, such as SNOMED, ICD-9, ICD-10, RxNorm and LOINC.

CCD Analyzer runs on common secure web portals (e.g., Internet Explorer, Firefox, Chrome, Safari), providing easy access and fast processing speed. The information presented is designed to be user-friendly and clinically relevant. Rules for CCD Analyzer are configurable both by weight and criticality, which may aid organizations to progressively increase the quality, or target specific improvement areas.

*While not described above, once you have normalized your EHR data, it becomes possible to begin adding Diameter Health's applications such as DH Predict and DH Envision.*

**DH Predict:** DH Predict offers solutions for predicting a variety of outcomes within a specified timeframe, including:

- 30-day readmission risk
- Mortality risk
- Fall risk
- Surgical site infection risk
- Medication-specific adverse events

DH Predict identifies patients at-risk of adverse outcomes to avoid penalties, capture incentives, and increase revenues. Most importantly, our predictive analytics improve the efficiency of care delivery and optimize patient outcomes for health systems and Accountable Care Organizations (ACOs).

**DH Envision:** DH Envision identifies gaps in clinical documentation by examining clinical details such as medications, labs, procedures and vital signs. Peer-reviewed research has demonstrated that inference rules can effectively notify providers of undocumented problems and improve the clinical accuracy and completeness of problem lists.

DH Envision yields information that organizations can use to infer when diagnoses may be missing from a patient's chart. Healthcare organizations are now able to populate their patients' problem lists with all evidenced conditions. This improved documentation enables:

- Better visibility of patient acuity and more accurate payer reimbursement
- Safer care transitions that don't miss key co-morbidities or care complications
- Improved benchmarking for payer programs profiling performance (e.g. readmissions)

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