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WHY IS IT SO HARD TO INTEGRATE TELEMEDICINE INTO EHRS?

EHRGuide

EXECUTIVE OVERVIEW

This white paper is a composition of a four part series of articles written by C. Rich Abbruscato in early 2018 that provides insight into just why so many organizations are struggling to integrate telemedicine into EHRs.

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In this white paper, Rich helps the reader better understand the question that integrators ask themselves of "which EHR"? Then he goes on to explain "what not to do".

Learn about a sensible approach for a telemedicine-to-EHR interface and how FHIR Lite Integration for Home Telemedicine (LIHT) may finally be the breakthrough that the telehealth and EHR industry has been looking for.

INTRODUCTION: FROM A TELEMEDICINE VENDOR'S VIEWPOINT, THE FIRST CHALLENGE TO INTEGRATION IS "WHICH EHR"?

There are more than 1,000 implementations of EHRs and not all of them follow recognized standards such as HL7 v2, HL7 v3, FHIR, openEHR and VISTA. Many have home grown infrastructures with interfaces to one or more of these standards for purposes of providing an integration path, making it a challenge to integrate telemedicine into EHRs.

These standards are quite different so providing an interface to each one requires effort. Worse still is that communications between two entities each having a standards based interface does not mean that those two entities will be able to pass information.

There is almost always some level of customization required.

THE DOMINANT EHR STANDARD IN THE FIELD TODAY IS HL7 VERSION 2.X

HL7 integration telemedicineHL7 version 2.x is the oldest EHR standard, originating in 1987. It provides an interoperability specification for health and medical transactions for hospital information systems.

It was developed in an ad hoc fashion to integrate various hospital systems such as between administrative and clinical. This allowed for rapid adoption since developers could concentrate on local conventions and issues. This heavy usage of local customization became baked in and made each integration task a custom effort. This spawned an HL7 integration engine business sector, which is still going strong today.

HL7 v2 with its field separators, component separators, subcomponent separators, field repeat separators, escape characters and most significant, the Z segments, is not complex, but every implementation is highly customized.

HL7 version 3 started in 1995 to address the short comings of HL7 v2. The standards professionals took control of this effort and did a top-down abstraction approach where the platform is agnostic and decoupled from implementation. The end result was a standard that is not directly implementable. The complexity of transforming the model from the abstract to concrete implementation elements was daunting. Even more discouraging, no two actual implementations would be compatible. Given the difficulties several early high visibility implementations encountered, adoption of HL7 v3 started slow and has tapered off from there.

But the short comings of HL7 v2 are so significant, that the standards oriented people did not give up. In 2011, an independent group of HL7 architects started on a new approach capitalizing on modern Internet capabilities – specifically REST (Representational State Transfer). This allows an implementation that is stateless, uses HTTP methods, uses XML (nice carry over from HL7 v3) or JSON (JavaScript Object Notation) as resource representations and has resources at predictable URLs. This new try is called FHIR (Fast Healthcare Interoperability Resources). As the R in FHIR implies, it is built on the concept of "resources" (e.g. Patient Resources, Device Resources, Document Resources).

By taking the RESTful approach and avoiding both the ad hoc approach of HL7 v2 and the top down approach of HL7 v3, it had an attractive beginning.

But FHIR is abstract and doesn't specify implementation details. (Sound familiar?) It is still being developed and while it has a lot of support, it doesn't have that many implementations in the field.

INTEGRATE TELEMEDICINE INTO EHRS? HL7 V2 REIGNS

In spite of its shortcomings and criticisms, HL7 v2 implementations rule. So, if you want to connect to the greatest installed EHR base, then you have to talk HL7 v2.

Over 90% of hospitals in the USA use HL7 v2 and it is unreasonable to expect them to rip out something that has been working (for many years) and replace it with something new and as yet unproven. New implementations are clearly the

best targets for FHIR. But to have relevance in an HL7 v2 world, a FHIR to HL7 v2 interface engine is needed for each of those FHIR implementations.

Since the RESTful approach of FIHR simplifies transversing the Internet it is ideal at the originating end of an interface transaction. The receiving end with an HL7 v2 implementation would need a FHIR interface engine. Easy for the originating end, but still an effort at the receiving end because of the local HL7 customization.

If FHIR could go beyond its abstraction rules a bit and specify a certain amount of implementation details specifically for telemedicine, then it could be extremely useful.

On the other side, if HL7 could pare back the myriad of local options to a core minimum needed for telemedicine, we could have a focused specification with relative ease of implementation.

WHAT ABOUT OTHER PROTOCOLS LIKE OPENEHR AND VISTA?

At their core, HL7 v2 and FHIR are messaging oriented. They provide guidance on moving information between systems. They don't specify how data is stored. OpenEHR is all about how to store information. It describes an efficient method of database mapping that enables rapid retrieval of information.

In the telemedicine world, the EHR is typically a separate entity and a key task for a telemedicine system is to get clinical information it gathers to that EHR. That is, once the telemedicine system collects clinical information, it's all about messaging to get that information to the EHR.

That leaves OpenEHR outside the theme of this discussion.

The Veterans Information Systems and Technology Architecture (VistA) is a nationwide information system and Electronic Health Record (EHR) developed by the U.S. Department of Veterans Affairs (VA). VistA consists of over 180 applications for clinical, financial, and administrative functions within a single, integrated database, allowing all applications to share a single, authoritative source of data for all veteran-related care and services. It has received particularly high marks for connectivity and utility as a clinical tool. VistA is open source.

Since VistA includes communications, it might make sense for a telemedicine system to use its available interfaces to get information from the telemedicine system into VistA. In fact for the few telemedicine systems chosen to be used within the VA, that would be expected. Outside the VA network, having a VistA interface is not common. Finally, the VA has announced that it does not intend to continue the development of VistA and will move to a commercial platform (from Cerner).

That leaves VistA outside this discussion series.

TAKE-AWAY ON THE APPROACH TO INTEGRATE TELEMEDICINE INTO EHRS

The big take-away from this review so far is that the telemedicine world needs to figure out how to live with HL7 v2.x and that FHIR has certain aspects to offer.

Let's talk about ways we can go about doing that.

WHAT NOT TO DO.

Earlier, we reviewed EHR systems and protocols of greatest concern to a telemedicine system seeking to pass clinical information to the EHR.

That revealed the confounding situation where the least rigorous (from an academic/theorist point of view) standard – HL7 v2.x – dominates and the newer rigorously structured standards have had a hard time gaining traction in actual usage.

LESSONS LEARNED FROM EFFORTS TO CREATE STANDARDS

Let's talk about the lessons learned from efforts to create standards and how telemedicine could benefit from them in going forward.

As important as rigorous structure might be in academic circles and with standards purists, what matters in a fast moving competitive environment is timely usefulness.

Communication today is built on the Internet. Up until recently, end points for telemedicine have been video conferencing set top platforms, PCs and tablets. Typically, the patient end station has the medical devices and needs to get that information to the clinician and into the EHR.

In many hospital telemedicine systems, both the clinician end and patient end stations are on the hospital network with access to the EHR.

Home telemedicine stations and Remote Patient Monitoring stations typically don't have direct access to the system's EHR. When the patient end point is a mobile device, access to the EHR is even more difficult.

In addition to the need to send medical device measurements into the EHR, it is becoming more important for the person at the patient end point to be able to view information from the EHR.

TELEMEDICINE DRIVING NEED FOR EHR STANDARDS

Where there is a need, solutions quickly follow. The telemedicine market is driving this need and it is going to be fulfilled with or without standards.

There are precedents for this so we have some insight into how this might unfold. The challenge is to learn from those precedents so we could do a better job in dealing with the current situation.

We saw one precedent in Part 1 where a flawed standard (HL7 v2) was embraced on an ad hoc basis and held off other highly structured, more abstract later standards.

HL7 v2 took off precisely because it was allowed to be done ad hoc. HL7 v3 could not unseat it. FIHR has a lot of merit, but still isn't complete enough or simple enough to have an impact.

WHAT CAN WE LEARN FROM THE MEDICAL DEVICE MARKET IN CREATING USEFUL STANDARDS?

At one extreme, look at the medical device market where governments specify standards to which everyone is forced to comply.

For example, the FDA requires compliance to its Quality System Regulations for medical devices used in the USA; in other parts of the world compliance to ISO 13485 is required.

As these standards demonstrate, creating a perfect standard that covers every medical device from high risk (e.g. implantables) to benign (e.g. stethoscopes) produces an unnecessarily high level of complexity for simple devices.

It doesn't matter if a requirement is illogical, excessive or burdensome; it must be met. (If you have ever wondered why medical devices are so expensive, here is the starting point for understanding.)

At the other extreme is the Internet of Things (IoT). It is charging along driven by market acceptance. No matter how much the purists point out its flaws and vulnerabilities, IoT will keep advancing.

LOOKING AT PROTOCOLS. WHAT NOT TO DO.

Another precedent to look at is one that is pertinent to telemedicine – ISO/IEEE 11073 Personal Health Device Communications.

Prior to ISO 11073, there were many medical devices that sent device results over a cable or over Bluetooth to a telemedicine hub station. Each device had its own communications interface, so the telemedicine hub had to design its

interface software to accommodate them. (Although this sounds very inefficient, the device interfaces were very simple and the individual integration effort small.)

With no device interface standard, the standards group had an open field and a receptive audience in the telemedicine industry. Hundreds of contributors participated and every kind of medical device was covered. And covered completely.

After about 10 years, it is estimated that there are only about 100 products in the field implementing the ISO 11073 protocol according to the Office of the National Coordinator for Health Information Technology (ONC). And most of those also have simplistic proprietary interface as integration alternatives, which continue to be used extensively.

While this is certainly not a failure, given such broad backing and having no competing standard to dislodge, ISO 11073 did not achieve the success initially hoped for. At risk of over simplifying, the problem was too much complexity.

To make all the participants happy (including those playing the role of "devil's advocate") completeness was required including unlikely or unusual scenarios.

The penalties for complexity are more difficult implementation, more difficult testing and more things to go wrong. Exactly what the KISS principle argues against.

THE FREE MARKET DOES NOT WAIT FOR COMPLETENESS AND HAS LITTLE TOLERANCE FOR UNNECESSARY COMPLEXITY.

Coming back to EHRs, new standards like FHIR and openEHR have a double burden – creating a standard that meets every possible requirement and supplanting a widely installed base.

It's no wonder that integrating telemedicine into the EHR world is so difficult.

But it doesn't have to be. There is a middle ground between a free wheeling ad hoc approach and an excessively complex standard in a free market.

APPROACH TO A TELEMEDICINE-TO-EHR INTERFACE.

We provided some examples that showed the impact of having no standards and having complex standards in choice driven markets. If a reasonable standard is not available when the market wants to charge ahead, it will do so making choices based on user acceptance.

A CHANCE TO SUCCEED

Let us outline an approach to integrate telemedicine with EHRs with a blend of rigor and ease of implementation that has a chance of succeeding in a free choice market.

The key is that rather than trying to satisfy 100% of the market needs, we'll satisfy 80% but with 20% of the effort. (Or better yet, in certain ways, satisfy 90% of the needs with 10% of the effort.)

This is a variation on the 20/80 rule that we see in certain aspects of health care. For example, it is estimated that 20% of the population accounts for 80% of health care spending.

With a focused approach, telemedicine has demonstrated that it can have a major impact in reducing the cost of the 20% of "high utilizers" by reducing hospitalizations and emergency room visits. It is significant to note that the applications and services addressing this 20% don't necessarily address the other 80% in terms of features or price. But the overall benefits are so great that this narrow focus is justified.

COVERING THE CORE OF TELEMEDICINE

Applying this 20/80 approach to telemedicine integration with EHRs, we can identify a standards based approach that covers the core of telemedicine in a sufficiently simple manner that competing companies would choose to use it rather than a home-grown proprietary method.

This is reasonable to accomplish because the primary focus of telemedicine is very narrow compared to the breadth of needs of a hospital EHR. The essence of telemedicine is about performing clinical tests on a remote patient and delivering the results to a clinician or database.

Doing other related things beyond that is sometimes lumped in to telemedicine, but for this analysis, we'll put them aside. If any of those activities can be swept up as part of handling the core telemedicine mission, then fine. But if additional burden is needed to do that, then that is the path which leads to complexity that can doom the entire effort. Therefore any such burden will be excluded from this initial approach.

The key for enabling this focused approach to succeed is for the EHR to perform all tasks within its scope and be open and available while a clinician performs the telemedicine session. The EHR will handle typical activities such as:

- Administration.
- Admit and discharge.
- Patient profiles, diagnoses, care plan, medications, lab tests, …

NON-TELEMEDICINE SESSION VS. TELEMEDICINE SESSION

In a non-telemedicine session, a clinician would enter notes directly into the EHR. If a clinician were to perform a test with a medical device (e.g. a blood pressure measurement) on a patient in his/her presence, he/she would manually enter the resultant measurement into the EHR.

For a telemedicine session, a clinician would have higher expectations. He/she would expect the results from a blood pressure measurement to be electronically entered into the EHR via a telemedicine-to-EHR interface. To enable that, the telemedicine system must use patient identities that the EHR recognizes. Those IDs would be used when configuring the telemedicine system. Since we're starting off with as few automated actions as possible, the clinician would have to log in to the EHR and log in to the telemedicine system. (This is a double entry task that can be dealt with later using tools like Single Sign On (SSO).)

GETTING OBSERVATIONS INTO THE EHR

What we need from a telemedicine-to-EHR interface is to get the results (what HL7 would call observations) of medical device measurements into the EHR. This would include images.

To accomplish this singular task both the telemedicine system and EHR would have a role to play, but it should be minimal. If the steps to accomplish this are built on a standard, then there is a better chance for broad acceptance and actual usage.

By using standards elements, it should be possible to gracefully add other standards based elements later.

To make the initial task as simple as possible, we can further narrow the scope by differentiating between institutional telemedicine and home/consumer telemedicine. Further, we'll differentiate between interactive telemedicine sessions with video and non-interactive sessions using systems called Remote Patient Monitoring (RPM).

TELEMEDICINE SESSION WITH VIDEO

In home telemedicine applications with video, during an interactive session between a clinician and a remote patient there is no clinician with the patient and the medical devices are few and simple.

Typical medical devices include a real-time stethoscope, a blood pressure meter, a pulse oximeter, weight scale and spirometer. (The actual mix would depend on the needs of the patient.) In addition, the clinician would be able to

view dermatological sites, wounds and some ENT views. This is the direction consumer telemedicine is heading.

Coming up with a telemedicine-to-EHR interface to handle this would be very timely and because there would be no standard to displace, has the potential of being widely accepted.

TELEMEDICINE SESSION WITHOUT VIDEO – REMOTE PATIENT MONITORING (RPM)

Home telemedicine systems classified as remote patient monitoring (RPM) systems typically do not have video and do not involve interactive sessions with a remote clinician.

The patients take medical device measurements on their own and the RPM hub asynchronously passes the resultant measurements to a central database for review by a clinician.

In addition, RPM systems typically include questionnaires for the patient. The questionnaire responses are also uploaded asynchronously to the central database. To the extent that the telemedicine-to-EHR interface for the interactive sessions can handle RPM systems, that is a plus.

However, a key element of RPMs is the patient questionnaire which is foreign to many hospital EHRs. It would be acceptable for complete RPM integration to come later.

OBJECTIVE: DEVELOP A TELEMEDICINE-TO-EHR APPLICATION FOR CONSUMER TELEMEDICINE WITH VIDEO AND MEDICAL DEVICES

So the very simplest forward looking telemedicine-to-EHR application would be consumer telemedicine to the home with video and medical devices. Other telemedicine sub-sectors could benefit from this, but satisfying the requirements of those sub-sectors should not impede the development and issuance of this first objective.

Let's look at an integration scheme that will build on FHIR and be targeted at consumer telemedicine. We'll call it FHIR Lite Integration for Home Telemedicine or (since we like acronyms) FHIR LIHT.

LITE INTEGRATION FOR HOME TELEMEDICINE USING FHIR LIHT.

Earlier, we tagged consumer home telemedicine as the simplest telemedicine-to-EHR application and therefore a good place to start.

Now, we'll look at an integration scheme that will build on FHIR concepts and be targeted at consumer home telemedicine. We'll call it Lite Integration for Home Telemedicine using FHIR (FHIR LIHT).

LITE INTEGRATION FOR HOME TELEMEDICINE USING FHIR LIHT

In this model, we want to get medical device observation information from a consumer home telemedicine system into an HL7 based EHR. The telemedicine system would typically be browser based and would be comprised of a patient station in a patient's home and a clinician station at a hospital or clinic from which the EHR would be readily accessible.

The nexus is the PC platform where the clinician logs into both the EHR and telemedicine system.

The telemedicine system handles the Internet communications to get the measurements from the patient station to the clinician station, where on the same platform an EHR session would be open. The messages containing that information should be in FHIR format.

(It is noted that Remote Patient Monitoring systems typically send data asynchronously directly from the home telemedicine station to a central database, which while technically an EHR is not a hospital HL7 EHR. In an RPM system, the patient takes measurements independently and a clinician is not actively involved. Since our focus here is on interactive video-based sessions and HL7 EHRs, this type of data exchange will be covered elsewhere.)

MESSAGING SHOULD BE BARE BONES AND FOCUS ON "OBSERVATIONS"

In spite of its odd notation (bars, hats, etc.), HL7 is more concise when it comes to observation messages. So we'll use HL7 OBX messages to guide the parameters in the FHIR LIHT to HL7 message conversion.

In this model, the telemedicine system would use FHIR LIHT for medical device observations destined for the EHR, which would use HL7 v2.x. That means that there would have to be a FHIR LIHT to HL7 conversion at that point.

To minimize that conversion effort, at the HL7 v2.x EHR:

- Limit codes and options. E.g. specify one code for blood pressure measurements. For home telemedicine applications it is generally not important to know which arm, or whether the person is standing or sitting or prone for the measurement. In cases where it is important, such detail could be recorded in Notes. Identify the best code for each medical

device commonly used in home telemedicine: blood pressure meters, pulse oximeters, spirometers/peak flow meters, weight scale.
- Allow for PDF images with related notes.
- Create the flexibility to accept and process messages where some "required" fields may not be filled in. It might be okay for the EHR to indicate an error for a message that is missing a required field, but the EHR should allow the message to be accepted.

THE LIMITED SCOPE OF A HOME TELEMEDICINE INSTALLATION

Take advantage of the limited scope of a home telemedicine installation versus a hospital installation.

A hospital environment has to allow for multiple patients at the same location as well as the same patient at multiple locations. It also allows for multiple clinicians, changing diagnoses and changing orders.

HOME TELEMEDICINE ENVIRONMENT

For the home telemedicine environment, there is a fixed location for each patient. While there might be changes over time, diagnoses are not dynamic and limited medical devices are involved.

As long as there is a means to get updates into the home telemedicine station, this information can be considered static for FHIR LIHT. When a home telemedicine station is installed, the following is generally known:

- Patient name and demographics.
- Patient location.
- Clinician name.
- Diagnosis.
- Orders where medical devices measurements are involved.
- Network location of the clinician.

This is information recorded in the EHR. Any of these elements that are entered into the home telemedicine station, must be done such that they are properly recognized by the EHR. The most obvious example is that the patient name and ID used by the EHR must also be used by the telemedicine system.

HOW CAN FHIR LIHT TAKE ADVANTAGE OF THIS?

For FHIR LIHT, there is no need to find or create or modify these "resources". All this information can be entered into the Patient Station as static information as an installation step to match the corresponding information in the HL7 EHR.

This reduces the core task of a FHIR LIHT conversion to translating FHIR LIHT observation messages to HL7 OBX messages.

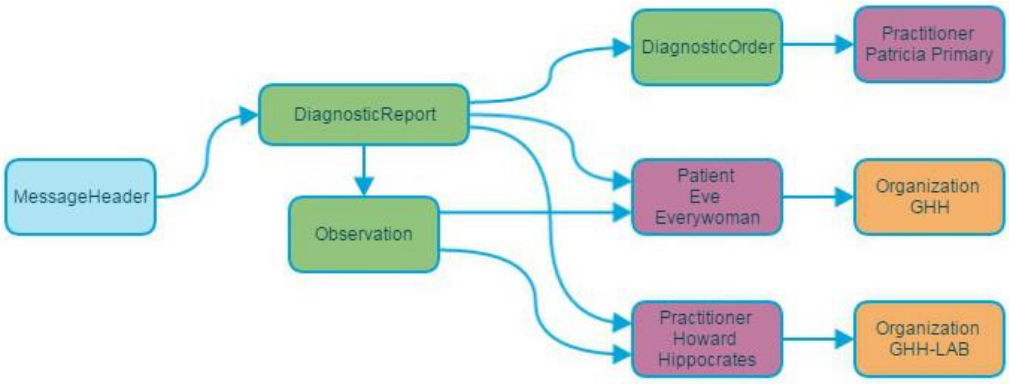
CONVERTING BETWEEN HL7 V2 OBSERVATION MESSAGES AND FHIR MESSAGES

Converting between HL7 v2 observation messages and FHIR messages is straight forward. The following link shows an example of an HL7 OBX message for a lab test converted to a bundle of FHIR messages.

http://www.ringholm.com/docs/04350_mapping_HL7v2_FHIR.htm

In the example at this link, Section 2.1 illustrates the use of bars, hats, etc. and that non-applicable fields cannot be ignored in the formatting of an HL7 message. Parsing an HL7 message requires every data element to be in a specified position. If a data field is not used, a blank space delimited by bars for that field must be included. It's not complicated but it is visually confusing.

Section 2.2 shows the FHIR message resources that are needed. The complete message bundle to handle the HL7 OBX is extensive. (Not complicated but extensive.)



http://www.ringholm.com/docs/04350_mapping_HL7v2_FHIR.htm

FHIR LIHT simplifies this bundle by eliminated the need for all the resource messages because that information was entered into the telemedicine system manually during installation (or update).

Eliminating the need for the resource messages doesn't just make the FHIR less verbose, more importantly, it eliminates the need to find or create or maintain the resources.

Once the HL7 OBX message is created, it has to get to the EHR so that the medical record for that patient is updated.

The co-residency of the telemedicine station and the EHR client station offers the potential of a local transfer of information. There are means of getting information from the telemedicine window into the EHR window, but they require

changes to the EHR system. That can be avoided by using a message transport method already employed by that facility to get HL7 messages to the EHR. There are known ways to do this and they will not be discussed here.

FHIR LIHT PROVIDES A REASONABLE PATH PREDICATED ON SIMPLIFICATION

FHIR LIHT doesn't solve all the challenges of getting home telemedicine observation measurements into an HL7 EHR. But it offers a reasonable path predicated on simplification.

That simplification is based on:

Recognition that consumer home telemedicine is very narrow in scope and data derived from it is limited and well defined.

Home telemedicine systems would enable entry of certain demographic and medical data that are derived from and match the EHR usage of that data. Use of FHIR resources is minimized.

The HL7 EHR would relax some of its rules for required fields for telemedicine systems.

Consumer home telemedicine with medical devices is a nascent market, but it is expected to be big. Having no standards for EHR integration will hurt the initial growth of this market sector. Many companies will try a home-grown approach which will make for a confusing environment which hinders growth.

This approach isn't perfect and doesn't handle all situations. But it does offer a standards based approach that is as easy to implement as a home grown telemedicine-to-EHR solution.

The goal of the FHIR LIHT approach is to make is so easy to get started that many will try using it. If the ease of implementation results in early success then it can form the basis of a de facto standard. If it can evolve to become more effective, it could become an official standard. (We can dream, can't we?)