Health Level 7: Barriers and solutions to full data integration in the Dutch healthcare sector

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ABSTRACT
The Health Level 7 standard is a very popular communication standard that is frequently used in the Dutch healthcare sector. Although about every hospital uses the standard internally, there seems to be almost no communication between healthcare organizations, especially when they are in a different healthcare layer. This research focuses on the main barriers preventing full data integration in the Dutch healthcare sector, the solutions mainly are to be found in an active attitude of the government, involvement of the clinicians and mobilization of the major organizations.

Keywords
HL7, Health Level 7, healthcare, communication, standardization, barriers, recommendations.

1. INTRODUCTION
Health Level 7 is a non-profit organization known for the message standards they created. These standards were created to provide an international standard in healthcare communication and are accredited by the American National Standards Institute (ANSI) [DAB06]. Before the HL7 standard every interface between systems was custom designed and were very costly to build and maintain. The amount of interfaces was very small but the costs and time involved were very high [IRS07]. Because of the benefits of the interfaces the need for a standard to reduce costs became high, this finally lead to the first HL7 messaging standard.

The HL7 standard evolved in the United States but is in use all over the world now. The standard exists since 1987 and today there are three main versions with subversions. Most healthcare organizations use a subversion of HL7 version 2 (2.2/2.3/2.4) [KGO02] [SD07]. HL7 is in use in almost every hospital in The Netherlands, primary for the exchange of medical, financial and administrative information between healthcare information systems [AIN]. The standard describes the exact syntax for the exchange of the information, since version 2 it also describes the document format which can be used (Clinical Document Architecture).

An example of a HL7 version 2 message can be seen in figure 1. This is an A01 message, the admission of a patient. The message includes information like the involved doctor and patient names. The main difference with a version 3 message is the structure, version 3 uses XML which is more clarifying.

Keywords
HL7, Health Level 7, healthcare, communication, standardization, barriers, recommendations.

2. PROBLEM STATEMENT
The Health Level 7 standard is being used all over the world but has not accomplished full data integration in the Dutch healthcare sector, this causes inefficiency and less available information to provide quality care.

To find an answer to this problem the following research questions are stated:
• What is the current status of the Health Level 7 standard adaptation?
• Who are the important stakeholders?
• What are the current barriers to full data integration?
• How to overcome these barriers?

2.1 Motivation
The HL7 standard works quite well within one healthcare organization [IRS07]. To achieve full data integration it is necessary to be able to exchange data between these organizations. With this research the barriers and possible solutions to achieve this will become clear.

The relevance is very high, people need healthcare and will not be treated within one organization all the time. These healthcare organizations need to communicate to achieve the care people need.

2.2 Limitations
Healthcare systems and all important legislation differ in almost every country, making it impossible to give a unified image of the current barriers and solutions. Another important aspect is the lack on external communication within countries, communicating internationally looks like a bridge to far at the moment. To limit the scope of this research it will be focused on the Dutch healthcare sector.

3. RESEARCH METHOD
The first part of the research consists of a literature research to get insight on the Dutch healthcare system and legislation. As healthcare systems are different in every country it is crucial to determine what organizations are involved and how they relate. Another important aspect is the current state of adaptation of HL7 in The Netherlands, which versions are in use and is there any exchange of information between healthcare organizations?

The second part will be a field research. To be able to discuss the current problems and how to solve them, it is important to know about the current important developments. These developments could cause problems or be a minor step to one of the goals. The important developments are extracted from papers, HL7 magazines and legislation proposals.

With all this information the field research part can be started. Only the people who are involved in HL7 on a daily base can say if their goals are accomplished or not. Also these people might have better inside information on the current problems and what is causing these problems. This field research will be based on interviews with experts on HL7. The following persons have been interviewed:

• R.A. Stegwee, chairman of Health Level 7 Nederland [IRS07].
• R. te Brake, information architect at the hospital Medisch Spectrum Twente (MST) [IRB07].
• M. Tan, project manager at Nationaal ICT Instituut in de Zorg (NICTIZ) [IMT07].

The information from the interviews will be the base of further literature research to support possible problems and solutions mentioned by one of the above experts. The information from the interviews and the conducted literature research can be used to set up a list of current barriers causing the HL7 adoption to slow down. At last the same information will be used to create recommendations on how to overcome these barriers and make full data integration in the Dutch healthcare sector possible.

4. CURRENT SITUATION
As said, it is very important to have good insight on the current situation. How does the Dutch healthcare system work and where is HL7 in use for internal or external communication? Of course there are also other players involved in healthcare communication standards, the most important ones will also be discussed.

4.1 The Dutch healthcare system
The Dutch healthcare system has multiple layers. The primary care layer is the one which is easiest to access in case you need any care related to your own health. Examples of primary care are general practitioners, dentists and the RIAGG [CAK07].

The second layer is the secondary care, which you can only go to with a referral from the primary care [BH99]. This could be a specialized doctor from a hospital but also a nursing home.

The last layer consists of laboratories and residence organizations [AK07].

In The Netherlands there is a focus on the primary care, in which the general practitioners play a central role [BH99]. General practitioners mostly use the EDIFACT standard [DJL95], which is older than HL7 and also incompatible with HL7. The usage of different standards between the layers causes external communication between healthcare organizations to be reduced to a very small number of interfaces. To be able to get a clear view on the current status a split up between internal and external communication is needed.

4.2 Internal communication
The amount of different versions of HL7 does not seem to be of any problem for internal communication [IRB07], because HL7 version 2 is backwards compatible. As circa 95% of all HL7 messages is still based on version 2 this does not give any problems within organizations [SD07] [IRB07]. From the interview with the MST hospital it seems that the main problems regarding internal communication within healthcare organizations lay in the fact that suppliers of the necessary software do not support the latest subversion of HL7 version 2 [IRB07]. Some hospitals for example have over 100 different interfaces running, mostly supported by tens of software suppliers [IRB07]. Some support all version 2 subversions, some do not and some only support certain subversions on certain kinds of links.

4.3 External communication
Currently there is almost no HL7 communication between healthcare organizations. Some hospitals have set up an interface with an important partner due to the financial advantages this creates [IRB07]. One of the most important kinds of external communication has not been implemented much, communication between primary care and secondary care. The main cause is the different standards these layers use [IRS07].

Within the primary layer EDIFACT is the most known standard. This standard is quite old (developed in the 80’s) and does not even function properly within its own layer [IRS07]. EDIFACT is based on rings, there is no easy solution for a country wide network between general practitioners for example [DJL95]. HL7 is not compatible with the EDIFACT standard and because of this the very few interfaces between the layers mostly consist of EDIFACT messages. This cross
layer communication mostly is between hospitals and nearby primary care [IRB07].

If someone wants to change to a new general practitioner due to moving houses, he or she will still need to move a huge amount of paperwork because of the limitations in the old EDIFACT standard. Another problem is the inefficiency due to redundancy caused by the lack of communication between the layers because of the non-compatible standards.

4.4 HL7 supporting organizations

There are multiple organizations supporting the HL7 standard. As the focus of this research is The Netherlands, the HL7 Nederland organization and Nationaal ICT Instituut voor de Zorg will be discussed.

4.4.1 HL7 Nederland

HL7 Nederland is a voluntary organization which is an official international affiliate. The organization exists since 1992 and mainly focuses on research, development, implementation and management. The most important tasks of HL7 Nederland are [AIN]:

- Promoting the usage of the HL7 standard
- Publishing HL7 specifications
- Represent Dutch members in an international context
- Organizing trainings and congresses
- Contribute to important HL7 implementations

4.4.2 Nationaal ICT Instituut voor de Zorg

NICTIZ is the national junction and knowledge center for ICT and innovation in the Dutch healthcare sector. A great amount of the investments from the government in ICT solutions for the healthcare sector are going through NICTIZ [IMT07]. NICTIZ manages the AORTA infrastructure which is the first serious infrastructure for communication between the healthcare layers. NICTIZ also has an important role in promoting HL7 usage and the creation of important projects, mainly this is in cooperation with HL7 Nederland [IMT07].

An important difference with HL7 Nederland is the version of the HL7 standard they support. NICTIZ’s opinion is that version 3 is the future and the only version suppliers and government should invest in [IMT07]. Another reason NICTIZ mentions is that HL7 version 3 is easier to use for communication between organizations, mainly because it is more precise and based on a Reference Information Model (RIM) [IMT07] [IRS07].

5. MISSION

What do we want to achieve with the HL7 standard? This is an important question, not only for the HL7 organization but also for the government and healthcare organizations. Of course the HL7 organization created a mission statement at the start of development, which is partly mentioned their strategies which had to lead to a worldwide HL7 adaptation. The HL7 organization has the following mission [WHI]:

“HL7 provides standards for interoperability that improve care delivery, optimize workflow, reduce ambiguity, and enhance knowledge transfer among all of our stakeholders, including healthcare providers, government agencies, the vendor community, fellow SDOs and patients. In all of our processes we exhibit timeliness, scientific rigor and technical expertise without compromising transparency, accountability, practicality, or our willingness to put the needs of our stakeholders first.”

HL7 Nederland agrees that the standard has mainly proven itself within organizations, their job is not completed yet as there still is a lack on external communication between healthcare organizations [IRS07]. This communication is essential to reduce ambiguity, optimize workflow and improve the care to the patients. It also is essential to the stakeholders, what are the most important barriers keeping them from exchanging important patient information and bringing patient care to a higher level?

6. IMPORTANT DEVELOPMENTS

To be able to answer the above question the important developments which are going on right now need to be clarified. It might be the case that some of the barriers can be overcome by current developments, also it could be the case that current developments need changes.

6.1 AORTA infrastructure

One of the biggest HL7 version 3 projects is the AORTA infrastructure. This project is under responsibility of NICTIZ, funded by Ministerie van Volksgezondheid, Welzijn en Sport [IMT07].

The AORTA is based on a reference index, it is not a central database with patient data [IRS07]. The main relations between the organizations regarding the AORTA infrastructure are displayed in Figure 1. The registry consists of the necessary data to authenticate organizations. The national routing point takes care of the information requests and the routing needed to get this information [NIC07]. Because the routing point cannot maintain partnerships with all healthcare organizations there are intermediaries: the care service providers. They will take care of the connection of organizations to the infrastructure [NIC07].

![Figure 2: Organizational aspects of the infrastructure NIC07]
as the necessary laws are accepted NICTIZ will go on with the implementation [IMT07].

NICTIZ names the infrastructure the Google for the healthcare sector [IMT07]. If an organization has a valid reason to request information about a patient this can be done over the infrastructure [IMT07]. Authentication will be done based on the UZI-card, which is a sort of digital passport [IRB07]. The goal is to have the most important patient records available on the infrastructure, to improve the possibilities for concatenational care and reduce the chance on mistakes [IMT07].

The UZI-card arranges the authentication of the requester or sender of information over the national infrastructure. This might look like an easy and logical component of the infrastructure but the problems with the UZI-card are causing the main delay on forcing the use of the medication dossier [IRB07]. These problems will be discussed in the barriers section.

NICTIZ is waiting on new legislation to be able to start the exchange of medical records to form patient dossiers [IMT07]. The main important developments regarding legislation will be discussed below.

6.2 New legislation

Laws are very important regarding the exchange of patient data. Internal communication is mostly allowed and regarded important by healthcare organizations [IRB07]. External communication might not always be allowed and also does not provide any financial or other advantages for most organizations. This is why there are new laws being developed: to get more speed into the adaptation process and to make some kinds of communication over the AORTA infrastructure completely legal [IMT07].

6.2.1 Elektronisch patiëntendossier

The EPD law proposal is still waiting to be approved but it is almost certain it will be. The EPD forces healthcare organizations to be connected to the national infrastructure and to build the dossiers they are involved with [IMT07].

The first two dossiers will be one for general practitioners and the second one is a medication dossier which has to be used by every organization which prescribes medication to patients [IRB07] [IMT07]. Examples of organizations involved are: pharmacists, hospitals and general practitioners.

6.2.2 Burgerservicenummer

Since 26 November 2007 everyone in The Netherlands has a burgerservicenummer. This number unifies the way healthcare organizations link patients to their information and that is the main reason of its importance [BSN07]. Without an unified way of linking people to medical dossiers and other information, a main reason of its importance [BSN07]. Without an unified way of linking people to medical dossiers and other information, a

6.2.3 Digital signing

NICTIZ currently has a project called digital signing [IMT07]. As the UZI-card also includes a digital signature it should be possible to reduce paperwork. At the moment papers have to be send to confirm digital requests, of course this is not a preferred situation and often seems ignored by organizations [IMT07]. NICTIZ is currently waiting for a new law to be able to implement digital signing [IMT07].

6.3 HL7 shift at general practitioners

As already mention, general practitioners are mainly using the EDIFACT standard. Currently there is a shift towards HL7, mainly because HL7 version 3 is needed for the national infrastructure. Almost all known Huisarts Informatie Systemen (HIS) suppliers have implemented HL7 version 3 or are working on the implementation [VAE05].

Of course this shift does not mean that HL7 is being used for the communication between primary care organizations but it certainly gives hope for the future as HL7 versus EDIFACT standard was like a religious discussion for a while [IRB07]. Suppliers now know the power of HL7 version 3 and might also implement it as an option next to the EDIFACT standard.

6.4 SNOMED CT

Next to structural interoperability there is semantic interoperability. The possibility of exchanging information does not mean that the exact meaning of it is clear to both organizations. On an international level this seems quite obvious but also within the borders this is a very important aspect.

For every single object or operation organizations need to use the same code or description, otherwise exchanging information would be useless. SNOMED CT connects medical information to a certain code and is available in multiple languages [DJ07]. This makes the exchange of information valuable and possible within and also outside the borders.

The important development is not the fact that SNOMED CT has been created, but that it is now available for free in nine countries (including The Netherlands), while the license costs were the main barrier to use it [DJ07]. This could lead to a wide implementation of SNOMED CT in the Dutch healthcare sector and could be an important step in the exchangeability of data.

7. BARRIERS AND SOLUTIONS

Now there is a view on the major parts of the Dutch healthcare sector and the interesting developments related to ICT, it is time to look at which barriers slow down the road to full data integration. Most past research focuses on the standard itself, some claim version 2 to be ambiguous and version 3 to abstract. But it seems the standard is not the main problem at all, the hospital MST for example does not have many problems creating new interfaces nor has much aging HL7 projects [IRB07]. To quote M. Tan, from NICTIZ [IMT07]:

“The lack on external communication between healthcare organizations is not primary caused by the technique used, but is more a problem of interests and investments in older standards and software.”

The barriers slowing down HL7 lay in multiple organizations, people and the current system. The main problems and solutions are discussed below.

7.1 HL7 organization

HL7 Nederland is a voluntary organization, running such an important organization on a voluntary base has its positive and negative sides. The main advantage is:

• The standard is being developed by people from the field which need to be able to use the final version of the standard. This leads to a standard which is actually usable [IRB07].

The main downsides are:
Volunteers also have their normal jobs, they will not get much free time to work on HL7 Nederland projects. This will mainly reduce the speed of developments and might also have its influence on the quality [IMT07].

As the volunteers are almost always people using HL7 they might not make the right choices to get standard implemented in other layers of the healthcare sector where they do not use it yet. The success of HL7 has much to do with the voluntary basis [IRS07], but the root of the main problems lay there as well: development speed and the lack of time available thanks to their employers [IMT07].

Another organizational problem is the structure and internationalization of the HL7 international organization [IRS07]. A huge part of the money and work for the HL7 standard is in the United States. This is not a good thing if you want the standard to evolve internationally. Also the volunteers in the United States would like to have the focus nationally and not internationally [IRS07]. This only makes things more difficult. Luckily the main investors also see an important market in Europe [IRS07]. The affiliates in Europe all want to achieve the same thing, but mostly in a totally different way. This has to do with the differences in their healthcare systems and legislation [IRS07]. The main result is an incoherent organization with a standard primary developed in the United States.

To overcome these problems while keeping the advantages of the current structure of the organization, HL7 Nederland should try to pay the volunteers or their employers for the most time consuming assignments. Also the focus should move from the United States to all involved countries. An international standard can only evolve if the attention and the amount of money are spread. Workshops and important meetings should not only be in the United States either, as it does not encourage internationalization.

7.2 Government
The Dutch government is a very important stakeholder with a huge influence, mainly based on legislation. M. Tan from NICTIZ made clear that they are waiting on legislation from the government before they will put more money and effort in their running projects [IMT07]. Many important new laws like the EPD are pending for a long time, with the EPD this is mainly because of problems with the UZI-pas [LUU07]. There is no clear roadmap for the adaptation of the EPD using the AORTA infrastructure as long as the government does not create certainty. It is questionable if such a roadmap should be created by the government and added to the new legislation, this would create certainty and give a clear view on the deliverables.

HL7 Nederland indicates that the Dutch government often wants things to be arranged too fast [IRS07], such a roadmap should be strict but deliverables should be able to be accomplished by all organizations involved. To make sure this will be the case, the Dutch government should discuss such a roadmap with HL7 Nederland and organizations representing the involved sectors. Examples are: “Landelijke Huisartsen Vereniging” and “NVZ vereniging van ziekenhuizen”.

7.3 Surplus value
The main reason that HL7 interfaces for external communication are not in use in that much is the demand for surplus value. Healthcare organizations need to communicate internally but external communication does not give much of advantage [IRB07]. The advantages for the patient when they are treated elsewhere are not very important to healthcare organizations [IRS07].

Even if external communication provides surplus value, it needs to be cheap and easy to use. If it costs a lot of work for the clinicians they will not use it as much as they should, an example is the UZI-pas which will be discussed in paragraph 5 [IRB07].

The only way to make healthcare organizations implement interfaces for external communication is legislation created by the government. However, it is very important not to forget the main important points for the organizations. The forced system should not cost too much money and should be easy and fast.

7.4 Suppliers
From the interview with R. te Brake from the MST it becomes very clear how much influence the suppliers of software have. Healthcare organizations use a wide variety of software suppliers for their HL7 interfaces, often for every department a different one [IRB07]. All these suppliers support different HL7 interfaces and mostly not the newest one.

In case of the MST hospital the suppliers often do not even support version 2.4 and 2.5, let alone version 3. This is an important barrier as version 3 is used in the national infrastructure and has better support for external communication.

The reason for the lack of version support is the time and money invested in the older standards [IMT07]. Implementing a new subversion of version 2 mostly consists of adding new possibilities, if this already is a problem the implementation of a complete new version will take a long time.

To get the suppliers to implement version 3 there seem to be only two options:

- Legislation, forcing the EPD would put a lot of extra pressure on the suppliers.
- Mobilization of the most important healthcare organizations to create a wish list and negotiate with the software suppliers.

Logically, if everyone has to communicate over the national infrastructure to create the EPD, the suppliers will have to adjust their software. If they do not, a competitor will. NICTIZ and HL7 Nederland already try to convince software suppliers to implement newer versions, but without the major organizations demanding it this will not succeed [IRS07] [IMT07]. Mobilization is an important aspect, hospitals managed to get suppliers to implement early version of HL7 while general practitioners did not [IRS07]. The difference was their degree of mobilization, hospitals could perform much more pressure on their suppliers.

7.5 UZI-pas
As said, the UZI-pas is used to authenticate the user which is requesting information on the national infrastructure. From the interview with the MST and NICTIZ it becomes very clear on the huge amount of problems with this small part of the infrastructure [IRB07] [IMT07]. While it is clear how important the UZI-pas is for the national exchange of patient data, this part of the infrastructure seems to be underestimated.

Next to the security the UZI-pas is also one of the main things which clinicians have to use. As described earlier, surplus value is not the only important factor for the implementation of
7.6 Clinicians

All changes in communication or other actions eventually have to be performed by the clinicians. R.A. Stegwee mentions this as one of the main problems, the clinicians do not seem to care about external communication and do not like changes in their daily routines [IRS07]. The HL7 organization already identified this problem and started a clinician council [IRS07].

If the influence of this council rises this could overcome and prevent problems. Things like the UZI-pas might have never happened because of the better communication with the people actually performing the daily tasks. Because of this the clinicians will feel involved in the process of change and the adaptation will go much smoother.

7.7 Standard diversity

As already mentioned in the introduction there are multiple version of HL7 version 2 and there is version 3. Version 2 is backwards compatible and does not give a lot of problems with the communication between interfaces on a different subversion [IRB07]. Communication between version 2 and 3 will be very hard and in the translation a lot of data will be lost [CN06].

This creates a huge barrier for implementations based on version 3, while this is very important and needed to communicate over the national infrastructure. The only solution to this problem is a good translation between version 2 and 3 [KGO02]. R. te Brake mentions this as the expected outcome of the new EPD law [IRB07]. If you leave this translation up to the software suppliers the same problems as mentioned in paragraph 4 might occur. A solution is to create a collaboration between HL7 Nederland and NICTIZ to build such a translator. This would reduce the costs for healthcare organizations and could reduce future barriers. The choice for HL7 Nederland and NICTIZ can be explained by the fact that NICTIZ has the necessary money and together with HL7 Nederland they also have the necessary knowledge from inside the community.

Next to HL7 there are also other standards in use, the most important one has already been mentioned: EDIFACT [DIL95]. The incompatibility causes huge barriers for the exchange of data between the different layers. As described in chapter 6, there is a shift towards HL7 version 3 due to the EPD law. It remains unclear if the primary layer is only going to use HL7 version 3 for the forced communication over the national infrastructure or if the shift will also include a slow movement towards the dispersal of the EDIFACT standard. If the national infrastructure is going to be a success, this problem will solve itself. There are many pilots running on the infrastructure which at last will make the EDIFACT rings useless, as all information will be available through the infrastructure.

7.8 Non-standard standard

In the introduction it is stated that HL7 is known as a non-standard standard [IRS07]. This is mainly due to the fact that version 2 leaves some choices open for the developer [SD07]. The main advantage has already been mentioned, every organization is unique and this way everyone can use HL7 while keeping the needed flexibility. The main problem this creates is in case of external communication. All parts of the communication that are non-standard will be hard to integrate with data from other organizations. HL7 version 3 has been designed with external communication as an important factor [SD07]. It has less possibilities for own creations and is based on a Reference Information Model, although some researchers do not agree with this [FS05] [SC06]. A solution to this problem is a very strict model for every dossier which is available over the infrastructure. With a translation service as described in paragraph 7 this will be controlled by NICTIZ for quite a big part.

7.9 Semantics

To be able to make the exchangeability useful the data needs to have the same meaning for the involved organizations. Currently there are standards in use for this, for example old version of SNOMED and the G-Standard [IMT07]. Still there are many different, often home-made, code systems in use [IRS07].

NICTIZ says they are negotiating with involved organizations about what standard to use [IMT07]. As finally legislation will decide what information needs to be exchanged over the infrastructure which is being managed by NICTIZ, they have the possibility to put some pressure on the involved organizations. As soon as the national infrastructure is fully working (and working properly) new legislation should be announced as quick as possible. This will give NICTIZ a lot more power to get things done.

7.10 Organizational changes

The new HL7 version 3 will be very important in all external communication, as this is a complete new version it logically requires some adaption of the organizations involved. A lot of the developers and analysts working with HL7 in the healthcare sector are already doing this for quite some time. As HL7 version three is completely XML based and also contains a RIM, it may often require additional training of the current personnel [IMT07].

Next to the training the clinicians will also have to adjust their daily routines, as mentioned in paragraph 6 [IRS07]. These two organizational changes are quite big and certainly are a barrier for the implementation of external communication interfaces like the EPD. The solution is to involve the personnel with the implementation within the organization and to train them properly [IMT07].

8. RECOMMENDATIONS

Based on the barriers and solutions described in chapter 7, there will now follow a list of recommendations for all stakeholders:

- HL7 Nederland should try to buy time from the employers of their volunteers, especially for the most crucial and time consuming tasks.
- HL7 Nederland should stay a voluntary organization, based on the people actually working with the standard in healthcare organizations.
- HL7 international should broaden their focus and put much effort in the internationalization of their own organization. This includes moving a part of the important workshops and other meetings to Europe.
- The Dutch government should stop postponing important laws, this causes major delay. Laws should be accepted quicker but should include a roadmap which has been formed together with organizations
involved. This roadmap should be strict but achievable.

- In case new information needs to be shared, the Dutch government should create new legislation forcing this, especially if there is no surplus value for the organizations itself.
- The important organizations in the Dutch healthcare sector should mobilize better (especially primary layer organizations). Together they stand much stronger in negotiations with their suppliers.
- UZI-pas problems should have a high priority, NICTIZ should not underestimate the importance of it.
- Clinicians should get more influence on the international HL7 developments. The clinician council can be a solution if their influence will grow.
- In case of new subversions of version 3, these have to be backwards compatible to prevent the creation of new barriers.
- NICTIZ and HL7 should join forces to create a translator for converting HL7 version 2 to 3 and vice versa.
- Primary care layer organizations should try to change their communication to HL7 version 3 as soon as possible. This should not only be for the communication over the national infrastructure.
- Wherever there is no standard in use for the semantics of the messages, HL7 Nederland and NICTIZ should try to make agreements with the organizations involved.
- Organizational changes for the implementation of external communication should not be underestimated. Personnel should get the necessary training but also should be involved in the implementation.

9. CONCLUSIONS
There is a long road ahead to overcome the main barriers and to be able to speak of full data integration in the Dutch healthcare sector. Many problems can be solved by clear legislation, but the Dutch government seems to postpone more laws than they are accepting. Most of the problems are related to external communication between healthcare organizations, fortunately there are many important developments which are necessary to overcome these problems.

The national infrastructure has a crucial role, to make this a success NICTIZ and HL7 Nederland should not count on the capabilities of the healthcare organizations and their suppliers, but should take things in own hands. External communication is not something which is regarded as important for them, while this absolutely is the case for their patients. The created list of recommendations could help them overcoming a lot of the barriers and speed up the adaptation process.

10. DISCUSSION
Due to limitations of the research, it might be the case that a certain amount of barriers have not been identified by this research. Future work will be important, the question is if any researcher will focus on the non-technical aspect of the HL7 adaptation process, as there is very few written about it at this moment. Important parts which need extra research are for example the change to HL7 version 3 in primary healthcare organizations and the organizational changes needed to be able to use HL7 version 3 for the external communication in healthcare organizations. These are mentioned in this research but to be able to accomplish the involved recommendations this needs to be made more profound.

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