

# A Study of XML / DTD Design and Application For Sharing and Managing Patients' Data - Focused on Patient-oriented Data

Jaeung Moon<sup>a</sup>, Seongwoo Choi<sup>b</sup>, Seongtae Yoon<sup>c</sup>, Giseon Jeong<sup>d</sup>

<sup>a</sup> Dept. of Medical Informatics, Graduate School of Hospital Management, Gachon Medical School, Korea

<sup>b</sup> Gachon Medical School, Professor, Korea

<sup>c</sup> Graduate School of Public Health Administration, Gachon Medical School, Professor, Korea

<sup>d</sup> Graduate School of Hospital Management, Gachon Medical School, Professor, Korea

## Abstract

Patient-oriented data (POD) was designed to share and manage patients' medical records among health organizations. It was coded by XML to increase patients' ability and willingness to do self health care and reduce the cost pressure on medical service providers.

To make it end, this paper used software for coding XML data. The meta-data used for setting the hospital information system in Korea served as the basis for designing the elements of POD, with references HL7, Japanese MML. This paper presented an application using POD and designed a network system of medical data exchange. POD was written for readers and patients, enabling them to read or understand their medical records and update, view, or modify them.

Designed with the patients in mind, POD can change health network systems and empower patients in many ways.

## Keywords :

Patient-oriented Data(POD), Medical Informatics, Health/medical record, self-healthcare, Medical XML

## Introduction

Medical and health informants face new challenges as the use of information technologies in health care explodes and patient involvement increases[1]. In Korea, one hospital gives patients access to their prescription records through the Internet.

The type of records is both in HTML and XML. Though coded in XML, the record could only be viewed but not conveyed to the patients' desktop computer or other hospitals' system. This is because XML is not used as the standard format for data exchange.

Patients could not understand their records because of their unfamiliarity with medical terminology. Other hospitals could not save the data into their own systems since each hospital has a different data format and data processing interface. Trying to have a standard format among hospitals entails high cost. In short, two problems are evident in terms of sharing and managing patients' records: (1) the cost, and; (2) the irregular data format. It is therefore necessary to design a system that can easily manipulate patients' records and allow them to understand medical structures and terminology.

With its electronic medical and health records for patients who are not knowledgeable on the medical arena[2], POD

can solve those two problems easily. This paper proposed POD as the solution for a new patients' records system. It is a very useful and effective data format for medical records because XML can be transferred to any type of data format[9].

Japan tried to make a Medical Markup Language eight years ago, exchanging its MML data with HL7 messages[6]. This paper considered the relationship between HL7 protocol, which is the existing medical data messaging protocols in terms of exchanging medical and health data.

## Method and Range

This paper chose outpatients as the subjects of the study. The website of KHIRA[4] was referred to set the meta-data of POD, since it was difficult to determine what types of data in medical records were most appropriate for its exchanging.

To develop a browser application, this paper used software such as MS visual studio.net and MS XML notepad to reduce grammatical error in coding XML, DTD, and XSL[9].

## Results

### Assumption about the model patient

The model patient afflicted with a virtual disease visited a hospital and he/she got some shots or a prescription. The assumptions about the model patient are shown in **Table 1**.

Table 1 - The assumption of a model patient in a hospital he/she visited

Disease Name	Cure	Shot	Pharmacy	Test
Disease A	Cure A	Shot A	Pharmacy A	Test A

This paper used variables like "shot A" because the information about "shot" in one hospital is different from another hospital; thus, a standard definition for "shot" should be made first. This assumption means that one patient's medical record, in the case of the outpatient assumed above, has four sections.

### Documenting POD into XML

POD consists of three parts: (1) PersonalInfo; (2) Hospitals, and; (3) Pharmacy. These were inserted in the XML

document as the first-child node. **Figure 1** represents the first part of POD. The first line “<?xml version=“1.0” encoding =“utf-8” ?>” indicates the version of POD and means that this document includes Korean and English letters[6]. The second line “<xmlns: POD=“URL”>” indicates the default namespace.

According to the XML grammar, POD distinguishes the capital letters from the small letters[9].

To understand this clearly, see the vertical relationship among the nodes. To represent POD as a unique XML document, “MofyEMR” was used as the root-node (or root-element). This can be changed during development if a more useful root-node is determined. In the case of Japanese MML, “levelone” was used as the root-node and each module separated by name-spaces[6].

```
<?xml version="1.0" encoding="utf-8" ?>
<MofyEMR xmlns:POD="http://www.worldmed.info/EMR/1.0">
```

Figure 1. The first part, included PI  
\*PI : Processing Instruction

(1) <PersonalInfo>

As shown in **Figure 2**, this section represents the personal profile and emphasizes one’s contact information; thus increasing the success ratio of contacting the patient in the future. This part should be written by patients using some tools such as an Internet browser. Patients can access and manipulate this information. POD needs the patients’ interest and participation; for their part, patients should keep their personal information updated.

This node consists of <MyName>, <JobInfo>, <Nationality>, and <ContactInfo>. The “Contact -Info” is especially important, since it includes the “address” (at least either the home or office address), “phone number” (at least landline or mobile), and email address.

```
<PersonalInfo>
  <MyName>
  </MyName>
  <JobInfo>
  </JobInfo>
  <Nationality>
  </Nationality>
  <ContactInfo>
  </ContactInfo>
</PersonalInfo>
```

Figure 2. The second part, <PersonalInfo>

(2) <Hospitals>

This node is separated into three: <InsuranceInfo>; <SelfSymptom>, and; <ClinicalVisit> (See **Figure 3**). <InsuranceInfo> contains the patient’s insurance information and <SelfSymptom> the symptoms that the patient felt. In the “SelfSymptom” node, patients can write their symptoms using common terms instead of medical terminology anytime. If they visit a hospital in the future, these symptoms may help doctors in curing or examining them.

<ClinicalVisit> is the key section. When a patient visits a hospital, his/her medical information rather than his/her profile is created and saved. <ClinicalVisit> consists of five segments: <HospitalInfo>; <Treatment>; <PrescriptionInHospital>;

<PharmacyTreat>, and; <Receipt>. <HospitalInfo> contains information registered in KHIRA[4] such as address, phone number, license number, etc. This allows patients to search the hospital they visited or where they were cured. This <HospitalInfo> part is not saved by the user; rather, it is inserted automatically from another XML document managed by hospitals. This paper assumed that each hospital had an XML document of its own information. The <Treatment> node includes the doctor’s opinions, information on shots, and clinical tests administered to patients. This section corresponds to “shot A” and “Test A” of **table 1**. The <PrescriptionInHospital> part, which is copied with “Disease A,” shows the clinical actions of doctors such as operation. The <PharmacyTreat> is a list of prescription drugs. This is designed to compare with <Pharmacydrug> in the <Pharmacy> node, which will be saved if the patient goes to a drug store. This way, the medical service provider or the patient can check whether he/she has taken the correct medicine as indicated in the prescription written by his/her doctor.

```
<Hospitals>
  <InsuranceInfo>
  </InsuranceInfo>
  <SelfSymptom>
  </SelfSymptom>
  <ClinicalVisit seq="1">
    <HospitalInfo></HospitalInfo>
    <Treatment></Treatment>
    <PrescriptionInHospital></PrescriptionInHospital>
    <PharmacyTreat></PharmacyTreat>
    <Receipt Visitnum="1"></Receipt>
  </ClinicalVisit>
</Hospitals>
```

Figure 3. The third part, <Hospitals>

(3) <Pharmacy>

The last section (see **Figure 4**) is <Pharmacy>, which contains information on the drug stores visited and medicines bought by the patient. The information on drug stores consists of their addresses, registered numbers, and profile of pharmacists, among others. It can be inserted automatically from another XML document managed by drug store.

In accessing POD, patients can know what medicines they bought and what drug stores they visited (see the full document at [www.worldmed.info/EMR/mofy.xml](http://www.worldmed.info/EMR/mofy.xml))[5]

```
<Pharmacy>
  <Visit seqnum="1">
    <VisitDate/>
    <Pharmacyinfo>
    </Pharmacyinfo>
    <Pharmacydrug listNum="1">
    <Pharmacydrug listNum="2"/>
  </Visit>
</Pharmacy>
</MofyEMR>
```

Figure 4. The forth part, <Pharmacy>

DTD Definition of POD document

In general, DTD validates XML documents [9]. This paper defined the DTD of POD. This includes an explanation of

the full structure and grammatical description of POD. **Figure 5** shows the part of DTD used in this paper (see the full document at [www.worldmed.info/EMR/mofy.dtd](http://www.worldmed.info/EMR/mofy.dtd)).

```

<!ELEMENT MofyEMR (PersonInfo, Hospitals, Pharmacy)>
<!ELEMENT PersonInfo (MyName, JobInfo+, Nationality, ContactInfo)>
<!ELEMENT MyName (FamilyName, FirstName, NickName)>
<!ELEMENT FamilyName (#PCDATA)>
<!ELEMENT FirstName (#PCDATA)>
<!ELEMENT NickName (#PCDATA)>
<!ELEMENT JobInfo (status+, memo+)>
<!ELEMENT status (#PCDATA)>
<!ELEMENT memo (#PCDATA)>
<!ELEMENT Nationality (Nation, NationalNumber)>
<!ATTLIST Nationality
  PhoneNumber CDATA #IMPLIED>
<!ELEMENT Nation (#PCDATA)>
<!ELEMENT NationalNumber (#PCDATA)>
<!ELEMENT ContactInfo (Phone+, Online+, Address+)>
<!ELEMENT Phone (FirstDigit, LastDigit)>
<!ATTLIST Phone
  calltime (eveningTime|everyTime|dayTime) "everyTime"
  area CDATA #REQUIRED
  equipment (wire|wireless) "wire">
<!ELEMENT Online (EmailAddr+, Homepage+)>
<!ELEMENT EmailAddr (#PCDATA)>
<!ELEMENT Homepage (#PCDATA)>
<!ELEMENT Address (ZipCode, City, Town, Province, DetailAddr)>
<!ATTLIST Address
  where (house|office|etc) "house">
<!ELEMENT ZipCode (#PCDATA)>
<!ELEMENT City (#PCDATA)>
<!ELEMENT Town (#PCDATA)>
<!ELEMENT Province (#PCDATA)>
<!ELEMENT DetailAddr (#PCDATA)>

```

Figure 5. A part of the DTD file.

### An application for Hospital CRM

To make a new structure for CRM, this paper used XSLT for conversion into HTML[8]. Patients were assumed to be interested to know what happened to them at the hospitals and drug stores.

**Figure 6** represents the CRM interface. Patients can view through the Internet their hospital visiting history arranged according to date. This contains the hospital's name, the name of the doctor who treated the patient, treatments, clinical fees, pharmacy, website of the hospital, its phone number, and information on the drug store. In accessing this information, the patients can know what happened at the hospitals and drug stores they visited. In the case of doctors, they can know the treatment they gave the patients. Nonetheless, there will be requirements to mediate the rights of viewing and manipulating the information (this paper did not arrange for the security part). Contents of CRM can be combined with what medical service providers want to offer the patients. For instance, a lots of contents can be created to report statistics on how many patients have a particular disease, status of inventory of medicines, etc.

### Designing Network System for exchanging POD via Databank

**Figure 7** represents the POD exchange and what patients can do in this network. In **Figure 7**, the Databank[6] functions as an Internet /Intranet Server and collects POD from contracted hospitals and drug stores through the Internet.

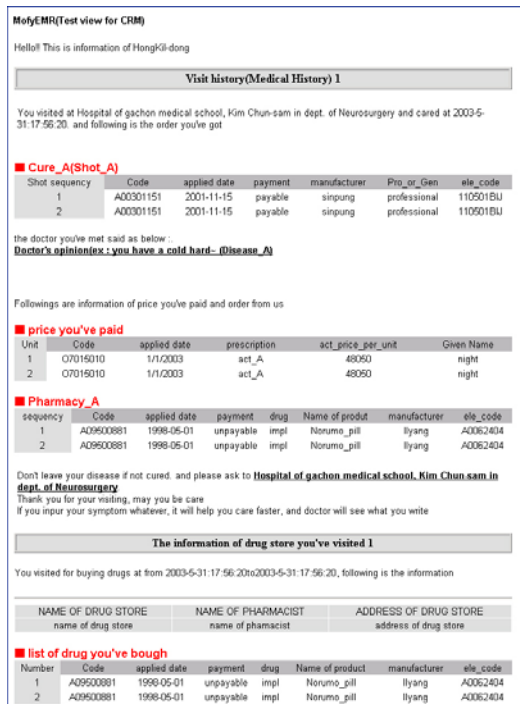


Figure6. The appearance in a browser. This shows for one visit of patient.

The databank is the common database system for medical organizations. Patients can update or modify their data and view their medical record by accessing the databank or the hospitals and the drug stores connected with the databank. In **Figure 7**, hospital A and hospital B can exchange their patients' records (POD) through the "www" interface linked with the XML interface for data retrieval. POD collected in the databank can be used in many ways such as CRM, hospital franchise, cooperation with another hospital, or statistic analysis after transferring adequate data formats or types (this is the strength of the XML). Contracted hospitals provide POD to the databank through HTTP or FTP. They can get other services from the databank for a fee.

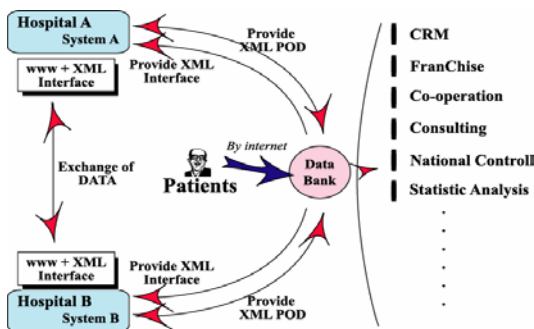


Figure 7. Network System Design for exchanging Patient-oriented Data

In the case of a person's POD document resulting from his/her visit to a hospital, the hospital can get his/her medical record from the databank through an agreement or some identified tools. When a hospital gets a patient's record from the Databank, the <ClinicalVisit> node is automatically created. For example, when patient X visits hospital A,

hospital A gets patient X's record from the Databank. As part of procedure, hospital A saves all information on patient X. Hospital A provides the databank with patient X's record. Later, patient X visits hospital B. Hospital B follows the same procedure. **Table 2** shows flow of formation X' record. As shown **table2** whenever X visit any hospital, X' record is added by sequence.

Table 2 - The sequence of formation X' record

1) X visits A	<ClinicalVisit seq="1"> ... (involved information of A) </ClinicalVisit>
2) X visits B	<ClinicalVisit seq="1"> ... (involved information of A) </ClinicalVisit> <ClinicalVisit seq="2"> ... (involved information of B) </ClinicalVisit>

### Relationship with HL7

The HL7 is a protocol to provide standards for the exchange, management and integration of data that support clinical patient care and the management, delivery and evaluation of healthcare services. Specifically, to create flexible, cost effective approaches, standards, guidelines, methodologies, and related services for interoperability between healthcare information systems[3].

It is being used in 22 countries. This paper distinguished the role of HL7 protocol and POD as shown in **table 3**. This paper cited these roles since they have common functions in processing medical data. Cooperation between HL7 protocol and POD should also be considered.

Table 3 - The each role of the HL7 and the POD.

The HL7	Target users: Medical / pharmaceutical organizations Role: Internal network message transferring protocol for data processing and exchange[3]
The POD	Target users: Patients Role: Outer network data format

### Conclusion

POD presents new challenges and opportunities in medical and health information technology. This paper achieved the following: (1) designed POD to increase patients' ability and willingness to undergo self health care; (2) defined the structure of the POD and made XML and DTD document; (3) made an application such as a hospital's CRM interface in the Internet browser, and; (4) designed a network system among medical/health organizations using POD. Eventually, POD can be a more useful data format, promoting more efficient networking among hospitals, drug stores, and patients. It allows hospitals and drug stores to work effectively together without paying more. Patients can also have a more positive and strong attitude toward their own health. Using POD, outsourcing in the medical field can be activated, human resources enhanced, medical objectives

met, and patients' rights promoted since their records can only be accessed upon their agreement and for specified purposes. Nonetheless, more studies on the subject should be conducted, particularly on the clear separation of rights between patients and medical service providers using POD, cooperation with other protocols such as HL7 and MML, and who will manage the central operation of POD.

### References

- [1] Bonnie Kaplan, Ph.D, Patricia Flatley Brennan, RN, Ph.D, *Consumer Informatics Supporting Patients as Co-Producers of Quality*, JAMIA, Vol.8, Num.4, 2001.
- [2] Matthew I. Kim, MD, Kevin B. Johnson, MD, *Personal health records : evaluation of functionality and utility*, JAMIA, Vol.9, Num.2. 2002.
- [3] HL7 Organization, <http://www.hl7.org>
- [4] Korean Health Insurance Review Agency  
<http://www.hira.or.kr>
- [5] Full files,  
<http://www.worldmed.info/EMR/mofy.xml>
- [6] Japanese Medical Markup Language  
<http://www.medxml.net>, 2003. 2.
- [7] Dan Wahlin, *XML for asp.net developers*, Mitepress, 2001.
- [8] Steven Hlozner, *Inside XML*, Digital Books, 2001.
- [9] XML 1.0 Spec, W3C Recommendation,  
<http://www.w3c.org/XML>

### Acknowledgement

All of files used in this study can be seen in website of <http://www.worldmed.info>.

In detail as follow:

- The model patient's POD  
: [www.worldmed.info/EMR/mofy.xml](http://www.worldmed.info/EMR/mofy.xml)
- DTD of POD  
: [www.worldmed.info/EMR/mofy.dtd](http://www.worldmed.info/EMR/mofy.dtd)
- XSL file used for transformation XML to HTML  
: [www.worldmed.info/EMR/mofy.xsl](http://www.worldmed.info/EMR/mofy.xsl)
- CRM view.(in html) : [www.worldmed.info/EMR/](http://www.worldmed.info/EMR/)

### Address for correspondence



Jaеung Moon, Master's degree of Business administration, Dept. of Medical Informatics, Graduate School of Hospital Management.  
1026-139 Hawangsimni 2dong SeongdongGu, Seoul, Korea. Postal code : 133-859  
E-mail : [w3master@multimoon.com](mailto:w3master@multimoon.com)  
Homepage: <http://www.worldmed.info>