Research for the Development of an OTC Medicine Dose/Treatment Guide Application for the Disadvantaged

Hyeonjeong Kim

Department of Industrial Design, Sangmyung University, Cheonan,Korea

Abstract

Background Information regarding a medicine printed on the packaging or dosage instructions is not being properly used as source of information sources by various users. This study aimed to revise and supplement the concept of the OTC medicine information deliverly system, which was proposed in the earlier study, to suit the information awareness features of the visually impaired and the elderly.

Methods The study developed an application by combining the NFC Tag and NFC Tag detection technology on a smart phone. The developed application consists of two parts: a writer application (Medi-writer) that allows for easily recordingOTC medicine usage information using a smart phone, and a reader application (Medi-helper) that dictates the OTC medicine information to the user. The detailed operation of the application is as follows: first the basic OTC medicine information is recorded to a NFC Tag via the writer application, and the NFC Tag is attached to the label of the medicine. Next, the reader application is activated by the NFC Tag detection sensor on a smart phone.

Results To confirm the usefulness of the developed application, the study conducted a verification test with twelve visually impared people and ten elders on the convenience and availability of the application. The test results showed that all participants evaluated the developed application and found it to be very useful and helpful in using OTC medicine information, giving an average score greater than 90 out of 100.

Conclusions The dose guide application developed in this study was targeted to increase the understanding of dose information and reduce the danger of misuse and abuse of medicine by providing additional information on dose instructions by using audio and visual information for elders and children.

Keywords OTC Medicine, Disadvantaged, IoT technology, Taking Medicine, Smart Phone, Guide Application

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2014S1A5A2A03066097)

Citation: Kim, H. (2017). Research for the Development of an OTC Medicine Dose/Treatment Guide Application for the Disadvantaged. *Archives of Design Research, 30(1), 101-113.*

http://dx.doi.org/10.15187/adr.2017.02.30.1.101

Received : Dec. 06. 2017 **; Reviewed :** Feb. 06. 2017 ; **Accepted :** Feb. 06. 2017
pISSN 1226-8046 **eISSN** 2288-2987

1. Introduction

Self-medication is gradually increasing since over-the-counter (OTC) drugs have been permitted to be sold in supermarkets. This has led to abuse and misuse of these drugs, and such safety accidents have been raised as social issues. The disadvantaged, such as the elderly, disabled, children, and the visually impaired, who have physical and cognitive problems in understanding labels and are vulnerable to acquiring information, are particularly more likely to experience medicine safety accidents and are at more risk than ordinary adults. Currently, various studies on assistive technology using the Internet of Things (IoT) are being performed in the Information Technolocy (IT) field, and interest in information delivery research using IT is increasing in the design field. However, IT design research on preventing the misuse of medicine and easy verification of medicine dose information by the disadvantaged, such as the visually impaired, elderly, and children, is considerably rare. In this aspect, a dose information guide application that can help the disadvantaged, who are physically or cognitively challenged at recognizing medicine information, was developed in this study through converged research on OTC medicine dose related information design and IoT technology. The objective is to solve various misuse, abuse, and dose problems related to medicine for elders, children, and the visually impaired, who have considerable difficulty in acquiring and using medicine information.

2. Current status of domestic and overseas research on information labeling of OTC drugs

Regarding domestic information labeling related regulations for OTC medicine, Article 56 of the Pharmaceutical Law "regulation on medicine labeling (details written on container)" exists and Article 56 of the Pharmaceutical Law presents guidelines and regulations related to medicine labeling. In addition, the Ministry of Food and Drug Safety is performing various studies on medicine labeling. Despite this, according to a survey on medicine safety management by the Korea Consumer Agency(2011), there are numerous visual or contextual issues in delivery methods and the representation of visual information, such as terminology, figures, font, and spacing, in information labeling of domestic OTC drugs by manufacturers. Regarding foreign research related to methods of providing medicine information, Hayes, K. (2005) conducted research on "Designing Written Medication Instructions: Effective Ways to Help Older Adults Self-Medicate" , which is about medicine information for the elderly with respect to visual, cognitive, and design aspects. "Educating Patients About Their Medications: The Potential and Limitations of Written Drug Information" by Shrank, W. H., and Avorn, J. (2007) is about the regulations of the formats and contents of medicine information on labels. In addition, the research on "Improving Patient Understanding of Prescription Drug Label Instructions" by Davis, T. C., Federman, A. D., and Wolf, M. S. (2008) is about methods of describing clear terminology to enhance the understanding of patients with poor reading ability, and about the significance of using clear terminology to describe instructions and dose frequency properly on medicine labels.

Through these domestic and overseas research papers and reports, the current status of information labeling in domestic OTC drugs was reviewed.

3. Research related to OTC medicine information awareness in the visually impaired

3. 1. Factual investigation of OTC medicine for the visually impaired

3. 1. 1. Purpose

Existing research on medicine information and informational content do not offer much practical help to the visually impaired , who have difficulty using text information. This study aims to examine in more detail the current status and problems of how the visually impaired use information on OTC medicine.

3. 1. 2. Method and Contents

As a preliminary study before conducting the survey on the visually impaired's use of the information on OTC medicine, the content and visual aspects of the labeling information on OTC medicine were analyzed by purchasing a total of 74 samples of 15 types of domestic OTC medicine by a manufacturer.

3. 1. 3. Result

The survey results showed that, in terms of content, there is no consistency in the format and order of displayed information on OTC medicine in Korea, and each manufacturer used different terminologies and different labeling designs for the location and display methods for the information on OTC medicine (the name of the product, efficacy/effect, properties, composition, dosage, precautions, storage method, packing unit, manufacturer information, expiration date, etc.). It was also shown that all 74 types of OTC medicine, except for three, offered little to no information in Braille, and even the information offered in Braille was mainly for describing the brand name of OTC medicine (for example, Bearse), and no Braille information was given about the type of the medicine (whether it is for cold or digestion) or how it should be taken. Furthermore, the font size, line-spacing, letter-spacing, and color on the labeling of all 74 types of OTC medicine made the displayed information almost unreadable even for normal users, showing that there was no consideration given to the socially disadvantaged, including the elderly, children, and the visually impaired. The analysis showed that the the labeling format implemented in domestic OTC medicine does not conform to KFDA (Korea Food and Drug Administration)'s Guidance on Pharmaceutical Labeling, which stipulates that (1) for the understanding of the consumers (particularly, illiterates or foreigners residing in Korea, etc.), the proper use of officially recognized codes, diagrams or drawings is generally advised; and (2) for the visually impared consumers' correct use of drugs, the key information of the usage manual for the household drugs should also be displayed in Braille.

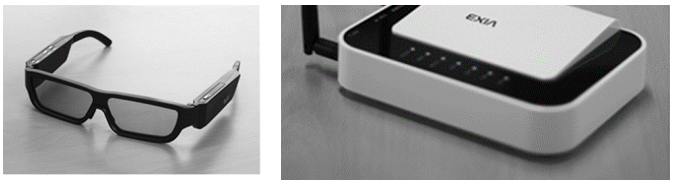

Figure 1 RFID goggle & transmitter

The research by Kang Wan Sik (2012) on medicine for the visually disabled included a plan to efficiently provide medicine information for the visually disabled. This research was about the standardization of location, designation, and labeling guidelines to efficiently identify barcodes on medicine cases, containers, and attached documents, for the visually impaired to use medicine safely. "Development of a RFID goggle to provide medicine information guidance to the visually impaired" by Kim JinYoung and Kang JoonHee (2014) was about assistive engineering research to design and manufacture a medicine information RFID goggle for the visually impaired and implement functions in the medicine guide for an RFID goggle, shown in [Fig.1], to analyze a tag attached on medicines though voice service. However, these studies do not offer solutions that can provide the visually impaired with necessary information on OTC medicine in real-time.

3. 2. Factual survey on OTC medicine targeting the visually impaired

3. 2. 1. Purpose and Contents

A preliminary study for developing an application helping with taking medicine conducted an in-depth one-to-one interview with 15 visually impaired people, as shown in [Fig. 2], asking questions on 1) the experience of using OTC drugs; 2) the frequency of the using OTC drugs; 3) the types of OTC drugs they frequency use; 4) whether they get help from others for taking or using OTC drugs; and 5) any problems in using OTC drugs.

Figure 2 Factual survey on information awareness in the visually impaired

3. 2. 2. Result

The survey results showed that all participants except one had high dependency on and high frequency use of OTC drugs, and as forthe problems in using OTC drugs, all 15 participants responded that the labeling on OTC drugs with regard to the basic medicine information, drug maintenance information, dosage, precautions, etc. was insufficient for them to use OTC drugs properly. The survey also showed that there was a lack of Braille information on drug labeling, and some labeling in Braille usually displayed the name of the drug based on the component of the drug or manufacturer, not drug-taking information. Furthermore, some parts of the information in Braille were misspelled, making it unreadable for the blind.

Thus, it was shown that not only the visual information on the label of OTC drugs but also Braille information could not help the visually impaired who would need medicine-taking information more than anyone else.

3. 3. Factual survey research on information awareness of OTC medicine in elders

3. 3. 1. Purpose

According to Consumer Safety Center's report in 2011, the elderly can exhibit different pharmacodynamic effects from normal adults due to the physiological changes as they age, and the use of various drugs for chronic diseases or complex diseases may result in increasing the frequency of adverse reactions caused by taking medicine. Therefore, the labeling of OTC medicine must be carefully considered for people who consume medicine by themselves, without a guardian or a specialist's prescription. Accordingly, this study targeted the elderly, who are considered to be a vulnerable social group in acquiring and using medicine information, and surveyed their awareness of the information on OTC medicine.

3. 3. 2. Method

As shown in [Fig. 3], the study conducted an in-depth interview with 18 elderly people in their seventies to nineties on 1) the experience of usingOTC drugs; 2) the frequency of the using OTC drugs; 3) the types of OTCdrugs they frequently use; 4) the storage and maintenance of OTC drugs;5) what information they considered the most important when taking OTCdrugs; and 6) the experience of side effects from OTC drugs.

Figure 3 Factual survey on information awareness in the elderly

3. 3. 3. Result

The survey on the elderly's possession of OTC drugs showed that most of the elderly owned five or more types of OTC drugs as household medicine, and the most frequently used OTC drug was dermatological ointments, followed by medicated patches, digestive medicines, cold medicines, and painkillers. The elderly considered "administration methods" and "efficacy/effect" to be the most important information on the use of medicines. Most household OTC drugs had been kept for more than six months.The survey also showed that most of the elderly had several diseases and owned and took prescription drugs and OTC drugs together, which demonstrated that they were always exposed to the risk of potential adverse reactions. Despite this, it was observed that most of the elderly do not heed precautionary information on medicine packaging. The causes of this were observed to be various problems in the label designs (size of text, sentence length, use of difficult terminology, color of text, placement), with no consideration for sight deterioration, cognitive ability deterioration, visibility features, and information processing ability in the elderly, as shown in [Table 1].

Table 1 Common Symptoms of the Elders

Physical disease	·Immobility ·Instability ·Impairment of vision & hearing ·Incontinence ·Irritable colon ·Infection ·Inanition ·Immune deficiency ·Impotence
Mental disease	·Intellectual impairment ·Isolation ·Insomnia
Environment disease	·Iatrogenesis ·Impecuniosity(poverty)

3. 4. Factual survey on information awareness of OTC medicine in children

3. 4. 1. Purpose

After targeting the visually impaired and the elderly, the study conducted a preliminary survey on the information awareness of children who cannot easily understand and acquire information on OTC drugs before developing a drug information application.

3. 4. 2. Method

First, the study presented 74 types of OTC drug samples to children and asked them to select 32 from these samples that they were familiar with.

The selected 32 samples were then used for the survey, and as shown in [Fig. 4], the following questions were asked to 25 elementary school students who had experience in taking medicine by themselves to examine their information awareness: 1) whether they have taken a medicine by themselves; 2) whether they can find out what the medicine is for only by reading the labeling information; 3) whether they accurately understand the dosage of the medicine and the method of taking it; and 4) what information on the labeling they find most difficult to understand.

Figure 4 Survey on information awareness and comprehnsion of informational content in children

3. 4. 3. Results

The survey was split into two surveys, one on information awareness and the other on the comprehension of informational content. The familiarity of 32 types of medicine and the awareness of medicine information (type and effect) were investigated in the information awareness survey, and 18 types of OTC medicine were used to investigate the comprehension of informational content.

In the result of the information awareness survey, 81% of the children observed had experience in consuming OTC medicine bythemselves; 34% of the children accurately identified the type of medicine among 32 medicine samples; 28% knew the exact usage of the medicine; and 44% accurately predicted the type of medicine using only the information on the packaging. In addition, it was observed in the comprehension of informational content survey that the following informational content was difficult to understand: precaution, components of raw materials, efficacy (effect), description (component), and dose (dosage). These results show that there is a cognitive problem, in the form of information labeling of domestic OTC medicine, for children in understanding and using medicine information. It was considered that visual and written information must be repeated and emphasized in order to deliver accurate medicine information to children.

4. Research on development of dose/treatment guide application

4. 1. Purpose and Contents

As shown above, the study surveyed the current status of the information awareness by the visually impaired, the elderly, and children to investigate the problems and current status in using medicine information by the information "have-nots." The results have shown that the existing information on the label of medicine does not offer practical help to them. Therefore, this study aimed to revise and supplement the concept of the OTC medicine information deliverly system [Fig. 5], which was proposed by the earlier study, to suit the information awareness features of the visually impaired and the elderly. Shown in [Fig. 6] is the revised conceptual map of the system.

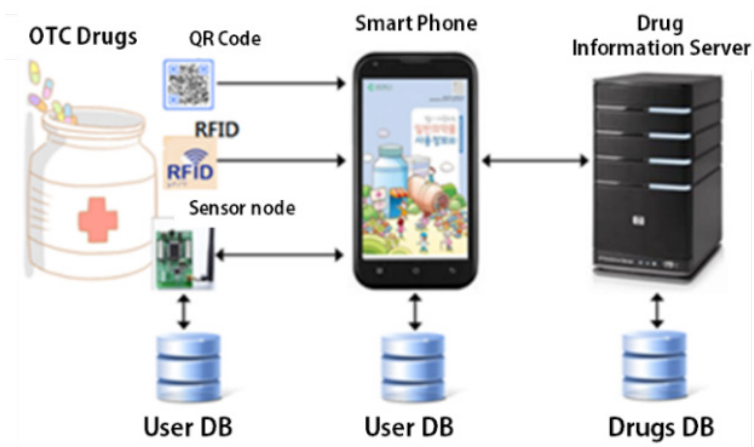

Figure 5 Configuration of IoT based medicine information delivery system

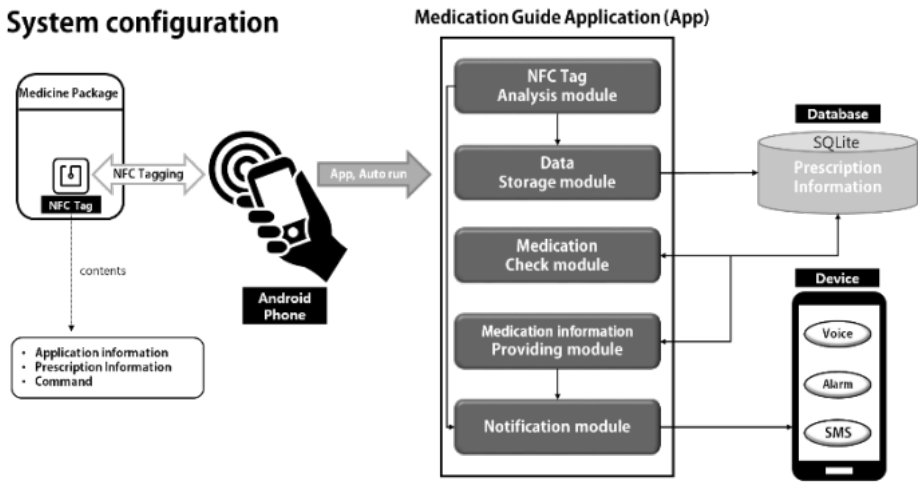

Figure 6 Smart phone application using NFC tag

4. 2. Detailed method and Contents

The basic concept of the research is to help users use information more conveniently and easily by removing the Drug DB from the conceptual map of the previous medicine information application system in [Fig.5]. As shown in [Fig. 6], the study developed an application by combining the NFC Tag and the NFC Tag detection technology on a smart phone.

The developed application consists of two parts: a writer application (Medi-writer) that allows for easily recording OTC medicine usage information using a smart phone, and a reader application (Medi-helper) that dictates the OTC medicine information to the user. The detailed operation of the application is as follows: first the basic OTC medicine information is recorded to a NFC Tag via the writer application, and the NFC Tag is attached to the label of the medicine. Next, the reader application is activated by the NFC Tag detection sensor on a smart phone, and as shown in [Fig. 6], if the smart phone touches the OTC medicine with an NFC Tag, it reads and dictates the basic medicine usage information of the target medicine. As for the dosage and other OTC medicine usage information, the elderly, the visually impared, or children can bring their smarthones in contact with the OTC medicine and the application on the smart phone dictates the type of the medicine (cold medicine, digestive medicine, etc.) and dosage information (once or three times per day / before or after each meal, or other medicine-taking information) and helps them pay attention to the medicine information and take medicine easily by themselves. The dose guide information that is contained in the tag is analyzed through a smart phone. TTS (Text-To–Speech) technology, which is an embedded module in Android smart phones, was used to convert dose related information into audio to be provided to the visually impaired or elderly. The developed application can be understood in two parts from the user's point of view. Medi-writer is an application for pharmacists and ordinary people, which is used to input the dose information. Medi-helper is an application that provides dose information to the disadvantaged. The application developed in this study selected low-cost, low-capacity tags after conducting a series of testing of diverse types of NFC tags in the development process according to the practicality and availability of the application for various types of users.

Furthermore, by considering the information awareness and attributes of memorization of the elderly or the visually impaired, the application programmed the structure of information stored in a tag into four stages, shown in [Fig. 7], namely the type/kind of the medicine, the time at which it should be taken, how the medicine should be taken each time, and precautions, so that the information can be repetitively used with the minimum memory capacity.

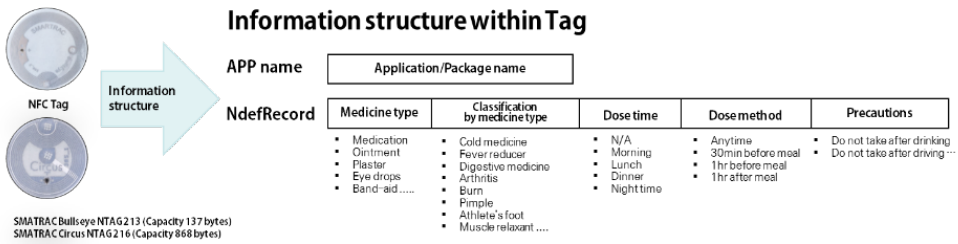

Figure 7 NFC tag structure that stores dose related information

In addition, 1 byte of code was saved for diverse dose information on low storage tags, which contained 137 bytes including medicine type, dose time, and dose instructions, as shown in [Fig. 7]. The information of each code value in the program was saved and managed in XML format, as shown in [Fig. 8]. In this manner, the dose guide application was programmed to use an XML document, which stored the information, and 1 byte of code that was stored in the tags, which the system was composed of, to provide sufficient information to users. However, precautions could not be mapped using codes and were configured to text values. Precautionary information that exceeded the tag capacity was restricted from being input to prevent confusion, based on the cognitive ability of users.

```
<?xml version="1.0" encoding="UTF=8"?>
<resources>
  <string-array name="category">
    <item>복용약</item>
    <item>연고</item>
    <item>파스</item>
    <item>안약</item>
    <item>밴드</item>
  </string-array>
  <string-array name="medi1">
    <item>감기약</item>
    <item>어린이 감기약</item>
    <item>해열제</item>
    <item>어린이 해열제</item>
    <item>소화제</item>
    <item>위장약</item>
    <item>진통제</item>
    <item>근육이완제</item>
    <item>수면유도제</item>
    <item>지사제</item>
    <item>영양제</item>
    <item>간장약</item>
    <item>비타민</item>
  </string-array>
```

```
  <string-array name="medi2">
    <item>화상</item>
    <item>여드름</item>
    <item>아토피</item>
    ......
    <item>항생제</item>
    <item>스토로이드성</item>
  </string-array>
  ......
  <string-array name="when">
    <item>식전30분</item>
    <item>식전1시간</item>
    <item>식후30분</item>
    ......
    <item>식간</item>
    <item>취침전</item>
  </string-array>
  <string-array name="meal">
    <item>구분없음</item>
    <item>아침</item>
    <item>점심</item>
    <item>저녁</item>
    <item>야간</item>
  </string-array>
```

Figure 8 XML configuration of medicine information storedin NFC tag

4. 3. Outcomes of the application development

4. 3. 1. Instructions for Medi-writer application

The process of using Medi-writer in is shown in [Fig. 9], and the order of the process is as follows: 1. Medi-writer application is downloaded from Google Play on a smart phone. 2. The downloaded Medi-writer is opened in the smart phone. 3. The contents of each item related to medicine information are selected and filled. The NFC tag is placed close to the smartphone and filled. 4. By placing the medicine with an NFC Tag. 5. The written tags are used according to their order of attachment on the medicine.

Figure 9 Information order of Medi-writer

4. 3. 2. Instructions for Medi-helper application

The process of using Medi-helper is shown in [Fig. 10], and the order of the process is as follows: 1. Medi-helper application is downloaded from Google Play on a smart phone. 2. The downloaded Medi-helper is opened in the smart phone. 3. A message appears about placing the medicine packaging close to the smartphone. 4. The medicine with an NFC Tag is placed close to the smartphone. 5. Dose information for the medicine is read aloud.

Figure 10 Information order of Medi-helper

5. Conclusion

To confirm the usefulness of the developed application, the study conducted a verification test with twelve visually impared people and ten elders on the convenience and availability of the application. The test results showed that all participants evaluated the developed application and found it to be very useful and helpful in using OTC medicine information, giving an average score of greater than 90 out of 100. Having received highly positive evaluation results, a patent for the developed application for OTC medicine was officially applied for in Korea on November 11, 2016 and further developed into a free application in order to promote its use by the socially disadvantaged class.

The developed application utilized relatively inexpensive NFC tags in consideration of the economic burden of the users and proposed an information delivery plan that allows for the maximum effect at minimum cost by using smartphones, which most people own and use. The dose guide application developed in this study was targeted to increase the understanding of dose information and reduce the danger of misuse and abuse of medicine by providing additional information on dose instructions using audio and visual information for elders and children. In addition, a voice information delivery plan was established for the visually impaired, who could not receive dose related information without a helper, to consume OTC medicine by themselves. In future research, it is planned to develop a prescription-based medicine dose guide application for the disadvantaged.

References

1 Beers, M. H., Berkow, R., Fletcher, A. J., & Besdine, R. W. (1995). *The Merck manual of geriatrics.* Merck Research Laboratories.

2 Consumer Safety Center. (2011). Report on Factual Survey of Medicine Safety Management

3 Davis, T. C., Federman, A. D., Bass, P. F., Jackson, R. H., Middlebrooks, M., Parker, R. M., & Wolf, M. S. (2009). Improving patient understanding of prescription drug label instructions. *Journal* of *general internal medicine, 24*(1), 57–62.

4 Hayes, K. (2005). Designing written medication instructions: Effective ways to help older adults self–medicate. *Journal of gerontological nursing, 31*(5), 5–9.

5 Kang, W. (2012). A study on effective approach to providing information on drug for blind. *Korea Blind Union Report.*

6 Kim, H., & Kim, M. (2016). Interface Study on the OTC drug Information Service Application. In Korean Society of Design Science Spring International Conference 2016 (pp. 32–33).

7 Kim, J. (2004). Analysis of Korean Design Study Tendency. *Jounal of Korean Society of Design Research, 17*(4), 159–168.

8 Kim, J., & Kang, J. (2014). Development of RFID Goggle to Provide Medicine Information Guidance to Blind Citizens. *Journal of Sensor Science and Technology, 23*(2), 122–126.

9 Korea Food & Drug Administration. (2012). Guideline on Labelling on OTC Medicine Container, Packing, Attached Document.

10 Lane, R. L., Ousland, J. G., & Abrass, I. B. (1989). *Essentials of clinical geriatrics*. McGraw Hill.

11 Notification of Korea Food & Drug Administration. (2009, August). Guidance on Pharmaceutical Labeling. *Korea Food & Drug Administration, 2009,* 224.

12 Notification of Korea Food & Drug Administration. (2011). Pharmaceutical Law. *Korea Food & Drug Administration, 2011*, 64.

13 Shrank, W. H., & Avorn, J. (2007). Educating patients about their medications: the potential and limitations of written drug information. *Health Affairs, 26*(3), 731–740.