

EVALUATION OF MOBILE APPLICATION FOR ANTICOAGULANT DRUG MANAGEMENT: IOS AND ANDROID PLATFORM

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Abstrak

Our goal was to identify the practical usage of medication management apps and what they can offer a consumer especially in their old age, keeping in view the aspect of medication adherence. A search of FREE medication management apps was conducted on app store of iPhone/Android operating system. Apps were included if they had a medication management system which included a reminder setup option and had an easy to use interface. Of the 22 apps on IOS and 18 apps on Android identified by strategy all met the inclusion criteria. WebMD and Drugs.com rated the highest among the apps because of their basic medication reminder feature coupled with their enhanced levels of functionality. WebMD was rated best for its information and usability which included a symptom checker, medication reminder, list of disease conditions, drug list with Indications, dosage information, side effects, drug interactions, drug use in pregnancy and lactation, first aid information, local health facilities listings, tests and procedures listings, healthy living tips, food and recipes. Finding a medication management app is challenging if you are looking for a specific type of apps as most of the apps are not tested by any authorized drug regulatory authority for example FDA. Almost all have no reviews and are not affiliated to any healthcare organization. Despite being untested, medication apps represent a possible strategy that pharmacists, healthcare workers, carers and family members of elderly patients can recommend for helping nonadherent patients and incorporate into their practice.

Key Word: Mobile Application, IOS, Android

Introduction

Older adults have high risk with multiple health problems such as cardiovascular disorders that may require anticoagulation therapy. Although, doctor suggested taking a blood thinner to reduce heart attack risk and stroke, they reported to be disappointed with the treatment and leading to poor adherence and reduced treatment value (Lee et al., 2014). This poor adherence can cause patient health adversely (Dayer et al., 2013). Moreover, nonadherence and medication errors are common among patients with complex drug regimens. Therefore, technology has important role to reduce this problems because technology in this era has high potential to promote health care. Technology innovation in health care can decrease inequality by delivering more accurate and individualized health care services to patients (Steinhubl et al., 2013).

There are lot of innovation in technology for health care. One of them is using mobile application to promote health behavior and

health care service. Apps for smartphones and tablets are effective for improving adherence, but they have not been tested in elderly patients with complex chronic conditions and who typically have less experience with this type of technology (Mira et al., 2014). A number of medication management apps are available on the smartphone app market to help consumers time their medications properly but none are targeted specifically for the elderly.

This study purposes to evaluate apps on two different platforms which are IOS and Android. Our evaluation will focus on application reminder management. After doing evaluation, we propose some features for medication management information system for blood thinning agents on mobile health application. The application will help the elderly to access information easily and user-friendly.

Methodology

In our methodology, we followed Bender et al. (2013) methodology which is identifying all related apps and studies systematic presentation and synthesis of the characteristics of the apps. However, we only reviewed two app stores: Apple Store (IOS) and Google Play (Android). Some keywords we used to find the apps for our evaluation. Those keywords are “Medication app”, “Anticoagulant app”, “Medication Errors”, “Medication Nonadherence”, “Medication Management”, and “Medication Reminder”. The result for these keyword was varied between Apple Store and Google Play. We found 22 applications for Apple Store and 40 of applications in Google Play.

Selection Criteria

In our search, we used free application and apps that relevant with our criteria. Our criteria are application for medication reminder and medication management. We limited our search for application with minimum 4 stars and highly recommended by Apple Store or Google Play. We also excluded non English apps. Therefore, for Android application we found 18 relevant apps to evaluate. Although some apps are duplicate, we do not eliminate in our evaluation. In total we evaluate 40 apps (22 apps on IOS and 18 apps on Android).

Discussion

What is Adherence?

The International Society for Pharmacoeconomics and Outcome Research (ISPOR) defines adherence as “The extent to which a patient acts in accordance with the prescribed interval and dose of a dosing regimen” (Cramer et al., 2008)

Medication nonadherence affects patient health adversely by negatively impacting a patient’s relationship with their care provider, distort results of clinical therapy trials leading to increase in health resource consumption (Ruddy et al., 2009, Waterhouse et al., 1993). Medication nonadherence is a common health care problem. Poor adherence causes approximately 33% to 69% of medication-related hospitalizations and accounts for \$100

billion in annual health care costs (Osterberg and Blaschke, 2005) . Irrespective of disease, the average adherence rate to chronic medication therapy is approximately 50% (Iihara et al., 2004). Adherence monitoring should be performed routinely to ensure therapeutic efficacy and avoid unnecessary dose and regimen changes in order to limit health care costs (Garfield et al., 2011, Weingart et al., 2008).

Measurement of adherence

Limitations to methods of measuring adherence include patient self-reports, pill counts, refill rates and electronic monitoring (Garfield et al., 2011, Cramer et al., 1989, Claxton et al., 2001). Patient self-reports are prone to inaccuracies as they rely on patient’s memory (Cramer et al., 1989). Pill counts are unreliable if patients fail to return bottles or dispose pills before the count (Osterberg and Blaschke, 2005). Refill rates or electronic monitoring cannot determine whether patients actually take the medication.

Medication electronic monitoring systems are useful for calculating adherence rates for dose taking and dose timing and are the best methods to measure adherence (Rolnick et al., 2011, Spilker, 1992, Paterson et al., 2002, Urquhart, 1997).

Medication Errors

“Medication Errors” accounts for injuries to approximately 1.3 million people annually in the United States.

The National Coordinating Council for Medication Error Reporting and [Prevention](#) defines medication error as "Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer related to professional practice, health care products, procedures and systems, including prescribing; order communication; product labelling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring and use" (Fda.gov, 2015).

What kinds of medication errors are most common?

The FDA evaluated reports of fatal medication errors from 1993 to 1998 and found that the most common medication errors were as follows:

- Administration of an improper dose of medicine (41% of fatal medication errors)
- Giving the wrong drug (16% of medication errors)
- using the wrong route of administration (16% of medication errors)

Almost 50% of the fatal medication errors occurred in people over 60 years of age. Older people are at a greatest risk for medication errors because they usually take multiple prescription medications (Fda.gov, 2015).

Prevention of medication errors

When given a prescription, always enquire about the name of the drug, the correct dosage, correct route, its use, storage requirements, and any special instructions related to food.

Always inform the prescribing doctor the names of all the prescription and non-prescription [drugs](#), [dietary supplements](#), and herbal preparations you use. If the name of the drug on your prescription bottle looks different than what your doctor ordered, if the directions appear, or if the pills or medication itself looks different, tell your doctor or pharmacist instantly. If you have any suspicions at all, asking questions is an easy way to steer clear of any medication error.

Evaluation Report of Medication Management Apps for IOS and Android

A. Characterization of Apps by purpose

1) Reminder Alert

All 22 apps for IOS and 12 apps for Android had the basic function of an alert setting option to take your pill on a particular set time.

2) Symptom Checker

There are eight apps (two on IOS and 6 on Android) had the symptom checker functionality where one can identify the cause of their symptoms to a certain degree.

3) Drug List and Indication

Of the 40 apps only 4 apps on IOS and 6 on Android (WebMD, Drugs.com (IOS & Android), Pocket Rx, My Meds, Drug Guide, Medscape, eBroselow, MedicinieList+, and MedAdvisor) had a vast drug list with indications which made it easier to choose rather than to type every drug separately that one is prescribed.

4) Dosage and Drug Interaction information

Four of 22 apps on IOS and 7 apps on Android gave correct dosage information due to the fact that they had a vast drug list in their database. They also gave a drug interaction list when 2 or more drugs were added for comparison.

5) Audio output

We found only two apps that have feature to record audio instruction to help remind user taking their medication. The apps name are Medica on IOS and MediSafe Meds on Android.

6) Rating

None of the apps had received a user review and the following message displayed “We have not received enough ratings to display an average for the current version of this app”. Making it clear that these apps had minimal or no implication in day to day life.

In addition, we make list of our evaluation (Table 1 and 2) based on Android platform and IOS.

Table 1 : Evaluation Apps on Android

Propose App	Reminder Alert	Symptom Checker	Drug List and Indication	Dosage and Drug Interaction information	Audio output & Record
Drugs.com Medication Guide (Drugs.com)		✓	✓	✓	
MediSafe Meds & Pill Reminder (MediSafe™)	✓				✓
CaraZona (CaraZona)	✓			✓	
Drug Guide (algotstudio)			✓	✓	
Medicare (WebMD, LLC)		✓	✓	✓	
Medicine time! (IMSoft Brazil)	✓				
AF-STROKE (FREE) (CardioNeurology Team)		✓		✓	
eBroaslow SafeDose (eBroaslow)		✓	✓	✓	
CML Today (CML Advocates Network)	✓				
Cosmos Pharma (Healthnet Ltd)	✓				
MedicineList+ (NPS Medicineswiss)	✓		✓		
MedAdvisor (MedAdvisor)	✓	✓	✓	✓	
iCancerHealth : Cancer Care (Medocity)	✓				
SilDiary Diabetes Management (SINOVO GmbH & Co. KG)		✓			
Chronic Pain Manager (MediSafe™)	✓				
Lady Pill Reminder (Baylux)	✓				
Med Helper Pill Reminder (EarthEars)	✓				
AppTaper Pill Reminder (amuzi)	✓				

Table 2 : Evaluation Apps on IOS

Propose Apps	Reminder Alert	Symptom Checker	Drug List and Indication	Dosage and Drug Interaction information	Audio output & Record
Medisafe	✓				
Pill Monitor	✓				
RxmindMe	✓				
Drugs.com Medication Guide	✓		✓	✓	
Pill Reminder by Drugs.com	✓	✓			
Pill reminder	✓				
Pill Alert	✓				
Medica	✓				✓
My Meds	✓		✓		
Medadvisor	✓			✓	
Perfect Pill Reminder	✓				
My INR+	✓				
Managing Dabigatran	✓				
Managing Rivaroxaban	✓				
Reversing Warfarin	✓				
Dose Cast	✓				
PocketRx	✓		✓		
WebMD	✓	✓	✓		
Medigaurd	✓				
INRLog	✓				
MedicineList+	✓			✓	
NOACguide	✓				

Result

On analyzing these 40 apps we found that these apps basically focused on setting off an alert at a particular set time of our choosing to remind us to take our medication. There were no other notable features in them except for 2 apps WebMD and Drugs.com

Both these apps had the following desirable functionalities:

- Easy to use without having to register for an account
- Symptom Checker
- Medication reminder
- List of Disease Conditions

- List of Drugs with side effects, dosage information, drug interactions, pregnancy and Lactation information

In addition the following functionalities were also available in the WebMD app

- First Aid information
- Local Health Facilities listings(Hospital, Pharmacy, GP clinic)
- Tests and Procedures Listings
- Healthy Living tips
- Food & Recipes

We need to consider the fact that in order to monitor efficient medication adherence the app should be able to:

- Easy to use for the elderly
- Inform career/family member and/or pharmacist that drug has been taken or missed.
- App should have an audio input and output functionality for easier use by elderly patients
- The app should update medication information (name, indication, dosage etc) by using an image of the medication prescribed (for example stored image in database of app or by scanning the barcode on medication)

Majority of the diseases treated by anticoagulants are related to cardio vascular disorders. Cardio vascular diseases affect people from all range of ages. From analyzing the Medication Reminder apps, we concluded that the following criteria should be kept in mind while suggesting an app for patients receiving Anticoagulant medication:

- An Easy interface for anyone to use.
- Video and audio instructions making it easier for elderly to use.
- Display correct drug name, dose and route of administration.
- Inform career/family member and/or Pharmacist about drug taken or missed via system updates.
- Maintain chart of INR (International Normalised Ratio of Prothombin time of blood coagulation) to achieve target goals.

- Information on major and minor side effects and immediate management of symptoms specific to prescribed drugs being taken. An alert should also be sent to career/family member immediately from the app.
- Anticoagulant therapy information in Pregnancy and Lactation.
- Images of prescription medications with audio output and adjustable font size should be used keeping in mind the elderly end user.
- A diet plan advising limitations and restrictions of certain food and food products that may interact with the prescribed anticoagulant drug.
- Consult with a Haematologist and a Cardiologist to get advice on any relevant medical information required to be added to the app for it to be considered functional by a medical board.

Application Design

Demand Analysis

Regarding to the application demand analysis, we need to consider the potential user's requirements and demands. Holzinger et al. (2011) explained that "the first step of medicine management application design is to determine and clarify the requirements and demands of the project". According to the opinions of Potteiger et al. (2015) individual apps are "designed to serve as a resource and should be critically appraised for validity before use. So we are concerned about the reliability of the medicine management application. For this medication management information system which is specific to anticoagulant drugs, at first, we need to confirm that it is a medication management information system, and then will grant it the characteristics specific for anticoagulant drugs. From the information of the medication management systems evaluation, we insist that this kind of software should direct users to use the correct medicine for anticoagulant therapy by identifying different disease symptoms. And we think it will lose the best users' experience and reduce the attraction, if we add the business function. Therefore, it is not necessary to design business function in this application. According to our group members' app research, most of the

common medication management app in IOS and Android are easy to use and user-friendly. Therefore, the app we designed is informative, innovative, easy to use, and user-friendly for older ages to attract our potential users and keep the maintenance of regular users. Then, we made a decision to design the anticoagulant drug information based system application in mobile. At first, the users need to have their account for this app via both sms verification and email registration, in order to provide the convenience to administrators to facilitate the account management. And regarding to the security issue, the app ought to protect the privacy of users and control the access of users. That means the administrator mechanism in this app is very necessary to be implemented. Moreover, according to the medicine application evaluation, the app should be easy to connect, since lots of potential users are old patients. As this app is designed for anticoagulant drug information based system, it mainly focuses on the indications, interactions and side effects of anticoagulant drugs and directs patients how to use anticoagulant drugs correctly according to their physicians' prescription. Additionally, the users or patients need a platform to share their experience and submit their questions on anticoagulant therapy. Moreover, the patients also get a diet advice according to their anticoagulant therapy from the application so as to minimise food related interactions.

Architecture and Function Design

Figure 1 Displays the Anticoagulant drug management application Architecture. At first, users can log on to this application via their mobile directly through sms verification and also through their emails whichever is their preference. Regarding the account security concern, we designed the administrator mechanism for the whole system, in order to maintain and detect this application. Moreover, another responsibility of this app administrator is to control and audit the questions and comments in Forum system. After logging in the system, user will go in to the home page, which is a very user-friendly and easy to use interface. There are six sub-systems in the Anticoagulant drug management system, Indications, Interactions and side effects of Anticoagulant

drugs, Anticoagulant drug list, Forum system, Health History system, Diet plan system and My Favourite system. In the Indications, Interactions and side effects section the user can check different drugs through word descriptions or video instructions, since users have different preference. Word description is very basic and video instruction is much easier for elderly to use. In the anticoagulant drug list, it displays correct drug name, dose, route of administration and pregnancy and lactation information. The anticoagulant drugs are rated by the counts that how many users add them to the favourite folder. Moreover, in the drug description, it will provide information on First Aid administration specific to reaction of prescribed drugs being taken. In the forum, users can interact with each other through submitting questions and answering questions. Moreover, users can also leave the comments about this application in the forum. In the Health history system, patients can update their personal health information, such as their anticoagulant therapy information. And additional function, drugs reminder, which can remind users to take relevant anticoagulant drugs according to their prescription is also present. It can also send a message to patients' family members/care giver to remind them which drug has been taken or missed by the patient. The diet plan system is linked with Health history system, since the system will help patients make a diet plan according to their personal health information which will inform patients the limitations and restrictions of certain food and some food that may interact with the prescribed anticoagulant drug. For My Favourite system, which is a user's personal folder in the system, the users can save the word descriptions or video descriptions about any information they find useful. The users can also save the anticoagulant drug instruction in their personal folder. Moreover, they can share the documents and videos in communication platforms like Facebook, Twitter etc. In the Forum system, the questions and answers submitted by users will be audited and detected by administrators. In order to improve the users' experience and satisfaction, users can comment about this app through the Forum system and the application can be updated according to customers' comments, requests and demands.

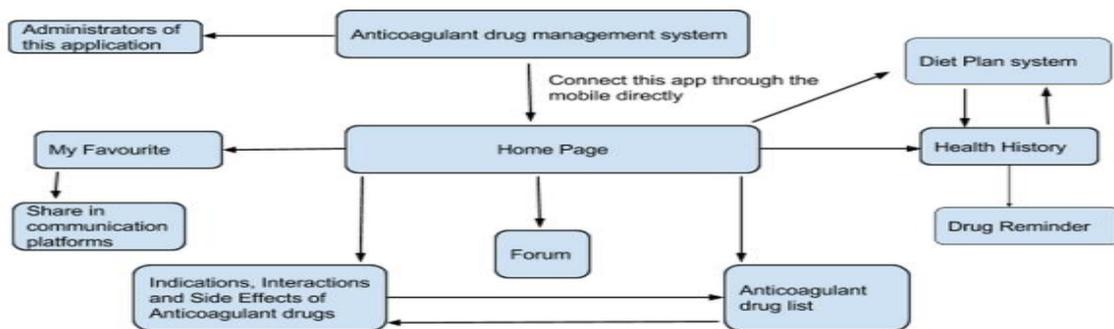


Figure 1. Anticoagulant Drug Management application Architecture

Features of our Anticoagulant Drug Management Application

1. This application can register users directly via sms verification and also let users register by their Emails (easy to register).
2. When users go into the homepage, there is a very user-friendly interface(user-friendly).
3. This application is an information based system without any business functions.
4. Users can save the word description and video description of indications, interactions and side effects of anticoagulant drugs and the anticoagulant drug instructions in their personal folder. Moreover, users can share them in communication platforms like Facebook, Twitter etc.(open source).
5. Users can update personal health record in the Health History system. And the Medicine Reminder function reminds users to take relevant medicines according to their personal health records.
6. The diet plan system will help clients make diet plan according to their personal health record.
7. The application grants users access to communicate with each other about the anticoagulant therapy experience in the forum. And users can also comment about this application in the forum.
8. The administrators in this application need to monitor and audit the questions and answers submitted in the forum to control and avoid negative messages left in the forum.
9. Anticoagulant drugs listed in the system are rated by the counts that how many users add them to the favourite folders.

Limitation of our Anticoagulant Drug Management Application

Our application design has limitations as follow:

1. The application is connected by user's phone directly via sms verification and as well as email. However, when user loses mobile or changes the mobile number, the account security issue will emerge.
2. Since this application is an information based medicine management system and we do not want to lose the user experience, we did not add business functions in this application. However, if there is no business functions to make money, the application cannot be maintained in the future.
3. The administrator in this application needs to monitor and audit the questions and answers in the Forum system. However, with the growth of users, the administrator could monitor and audit all the questions and answers in the Forum system, which requires a standardised policy in the system to make the application monitor and audit the questions and answers automatically.
4. This Anticoagulant Drug Management application needs to follow the government policies and rules. Since we are student team which do not have the professionals in this area, there is no concern about the government policies and rules.

Conclusion

Medication nonadherence is a fundamental health care challenge. Adherence apps are inexpensive and easily accessible on smartphones. These apps can be considered a possible strategy for pharmacists to recommend to nonadherent patients and to incorporate into their practice. Although none of the evaluated apps possess every desirable attribute, 2 apps were identified that offer the widest range of features and would be the most appropriate to recommend to patients currently for drug related information and as a Drug Reminder App. We design anticoagulant application with some features that easy to use, user-friendly and open sources for elderly users. Our apps provide update information for users.

References

- BENDER, J. L., YUE, R. Y. K., TO, M. J., DEACKEN, L. & JADAD, A. R. 2013. A lot of action, but not in the right direction: systematic review and content analysis of smartphone applications for the prevention, detection, and management of cancer. *Journal of medical Internet research*, 15.
- CLAXTON, A. J., CRAMER, J. & PIERCE, C. 2001. A systematic review of the associations between dose regimens and medication compliance. *Clinical therapeutics*, 23, 1296-1310.
- CRAMER, J. A., MATTSON, R. H., PREVEY, M. L., SCHEYER, R. D. & OUELLETTE, V. L. 1989. How often is medication taken as prescribed?: A novel assessment technique. *Jama*, 261, 3273-3277.
- CRAMER, J. A., ROY, A., BURRELL, A., FAIRCHILD, C. J., FULDEORE, M. J., OLLENDORF, D. A. & WONG, P. K. 2008. Medication compliance and persistence: terminology and definitions. *Value in Health*, 11, 44-47.
- DAYER, L., HELDENBRAND, S., ANDERSON, P., GUBBINS, P. O. & MARTIN, B. C. 2013. Smartphone medication adherence apps: potential benefits to patients and providers. *Journal of the American Pharmacists Association: JAPhA*, 53, 172.
- FDA.GOV 2015. Medication Errors. [online] Available at: <http://www.fda.gov/drugs/drugsafety/medicationerrors/> [Accessed 17 Oct. 2015].
- FDA.GOV 2015. Strategies to Reduce Medication Errors: Working to Improve Medication Safety. [online] Available at: <http://www.fda.gov/Drugs/ResourcesForYou/Consumers/ucm143553.htm> [Accessed 17 Oct. 2015].
- GARFIELD, S., CLIFFORD, S., ELIASSON, L., BARBER, N. & WILLSON, A. 2011. Suitability of measures of self-reported medication adherence for routine clinical use: a systematic review. *BMC medical research methodology*, 11, 149.
- HOLZINGER, A., KOSEC, P., SCHWANTZER, G., DEBEVC, M., HOFMANN-WELLENHOF, R. & FRÜHAUF, J. 2011. Design and development of a mobile computer application to reengineer workflows in the hospital and the methodology to evaluate its effectiveness. *Journal of biomedical informatics*, 44, 968-977.
- IHARA, N., TSUKAMOTO, T., MORITA, S., MIYOSHI, C., TAKABATAKE, K. & KUROSAKI, Y. 2004. Beliefs of chronically ill Japanese patients that lead to intentional non-adherence to medication. *Journal of clinical pharmacy and therapeutics*, 29, 417-424.
- LEE, J.-A., NGUYEN, A. L., BERG, J., AMIN, A., BACHMAN, M., GUO, Y. & EVANGELISTA, L. 2014. Attitudes and preferences on the use of mobile health technology and health games for self-management: interviews with older adults on anticoagulation therapy. *JMIR mHealth and uHealth*, 2.
- MIRA, J. J., NAVARRO, I., BOTELLA, F., BORRÁS, F., NUÑO-SOLINÍS, R., OROZCO, D., IGLESIAS-ALONSO, F., PÉREZ-PÉREZ, P., LORENZO, S. & TORO, N. 2014. A Spanish pillbox

- app for elderly patients taking multiple medications: randomized controlled trial. *Journal of medical Internet research*, 16.
- OSTERBERG, L. & BLASCHKE, T. 2005. Adherence to medication. *New England Journal of Medicine*, 353, 487-497.
- PATERSON, D. L., POTOSKI, B. & CAPITANO, B. 2002. Measurement of adherence to antiretroviral medications. *Journal of acquired immune deficiency syndromes (1999)*, 31, S103-6.
- POTTEIGER, K., BROWN, C. D. & KEELEY, K. 2015. The Use of Apps in Athletic Training, Part II: Applications for Clinical Management. *IJATT*, 20.
- ROLNICK, S., PAWLOSKI, P., BRUZEK, R., HEDBLUM, B., ASCHE, S., FUSTGAARD, M. & MEIER, D. 2011. PS2-32: barriers and facilitators for medication adherence. *Clinical medicine & research*, 9, 157-157.
- RUDDY, K., MAYER, E. & PARTRIDGE, A. 2009. Patient adherence and persistence with oral anticancer treatment. *CA: A Cancer Journal for Clinicians*, 59, 56-66.
- SPIPKER, B. 1992. Methods of assessing and improving patient compliance in clinical trials. *IRB*, 1-6.
- STEINHUBL, S. R., MUSE, E. D. & TOPOL, E. J. 2013. Can mobile health technologies transform health care? *JAMA*, 310, 2395-2396.
- URQUHART, J. 1997. The electronic medication event monitor. *Clinical pharmacokinetics*, 32, 345-356.
- WATERHOUSE, D. M., CALZONE, K. A., MELE, C. & BRENNER, D. E. 1993. Adherence to oral tamoxifen: a comparison of patient self-report, pill counts, and microelectronic monitoring. *Journal of Clinical Oncology*, 11, 1189-1197.
- WEINGART, S., BROWN, E., BACH, P., ENG, K., JOHNSON, S., KUZEL, T., LANGBAUM, T., LEEDY, R., MULLER, R. & NEWCOMER, L. 2008. NCCN Task Force Report: Oral chemotherapy. *Journal of the National Comprehensive Cancer Network: JNCCN*, 6, S1-14.