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CORONARY STENT AND PROSTHETIC HEART VALVE INFORMATION VIA SMARTPHONE NEW APPLICATIONS IMPROVING HEALTH-CARE QUALITY OF PATIENTS HAVING UNDERGONE PERCUTANEOUS CORONARY INTERVENTION AND ARTIFICIAL VALVE REPLACEMENT

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Abstract

There are a huge number of patients who have been treated by percutaneous coronary intervention (PCI) with stenting. Many studies have reported that cessation of antiplatelet medications produces in-stent thrombosis in patients, especially those with drug-eluting stent. Also, patients with mechanical prosthetic valves must not stop the anticoagulant therapy even in the late postoperative period, irrespective of type of the valve or position in the heart. However some people voluntarily abandon taking the antiplatelet or the anticoagulant medicines when they encounter an unexpected emergent medical problem. We have made a hypothesis that

smartphone based ubiquitous system of recording coronary stent information and prosthetic heart valve data would be useful in managing patients, who underwent PCI or artificial heart valve surgery. We developed smartphone applications archiving PCI and prosthetic heart valve data, "Coronary Stent Information" and "Prosthetic Heart Valve Information", respectively. These simple and free applications run on iOS or Android. More than eighty percent of participants approved one of these applications. We concluded that coronary stent and prosthetic heart valve data recording systems using smartphone technology are simple and valuable methods in managing people suffering from ischemic or valvular heart disease. These ubiquitous applications would improve health-care quality of patients who have undergone PCI and prosthetic heart valve surgery.

Keywords

Heart Disease; Cardiac Surgery; Percutaneous Coronary Intervention; Coronary Stent; Prosthetic Heart Valve; Health-Care

1. Introduction

There are a huge number of patients who have been treated by percutaneous coronary intervention (PCI) with stenting (Kupferwasser, et al. 2007). Two types of stents are used commonly for PCI; bare-metal stent and drug-eluting stent (Brodie, et al. 2008). Many studies have reported that cessation of antiplatelet medications produces in-stent thrombosis in patients, especially those with drug-eluting stent (Schofer, J., Bode, C., & Silber, S. 2004) (Yamaji, K., et al. 2016). Patients implanted with bare-metal stent also needs antiplatelet medication during early post-operative period (Newsome, L. T., Weller, R. S., Gerancher, J. C., et al. 2008). This complication might lead to a lethal condition in clinical practice. Therefore those who have treated with the bare-metal stent do must not discontinue antiplatelet therapy during early post-operative period. And who can tell that medical condition in an unexpected as well as communication disorder circumstances.

For patients who require prosthetic heart valve replacement, two options exist: mechanical and bioprosthetic valves. Each prosthetic valve has specific risks and benefits (Lund, O., & Bland, M. 2006) (Zhao, D. F., et al. 2016). Mechanical valves are thrombogenic and therefore require life-long anticoagulation. Bioprosthetic valves require shorter anticoagulant

agents and carry a higher risk of reoperation due to valve degeneration. Artificial valve implanted patients have to take warfarin (COUMADIN®) according to the rules; guidelines from the American College of Cardiology, the American Heart Association, the European Society of Cardiology, and the Japanese Circulation Society. Patients with mechanical prosthetic valves must not stop the anticoagulant therapy even in the late postoperative period, irrespective of type of the valve or position in the heart (Chesebro, J. H., Adams, P. C., & Fuster, V. 1986) (Bayliss, A., Faber, P., Dunning, J., et al. 2007). However some patients, especially after their uneventful postoperative years have passed, voluntarily abandon taking the anticoagulant medicine when they encounter an unexpected medical event. If the medical history of valve-implanted patients could be accessible any time and throughout the world, the cancellation of warfarin could be prevented at all times.

2. Hypothesis

Smartphone based ubiquitous system of recording coronary stent information and prosthetic heart valve data would be useful in managing patients, who underwent PCI and artificial heart valve surgery.

3. Methods and Results

We developed smartphone applications archiving PCI and prosthetic heart valve operation data. These simple and free applications run on iOS or Android.

3.1 Coronary Stent Information

The application records the procedure date, the coronary location of operation and the type of stent in the memory of smartphone. Touching the application icon makes the main view open showing a new (Figure 1) or an existing list of the recorded operation. Right upper '+' or 'adds FILE' button allows users to open edit page (Figure 2) to input the details of the case. The 'OP Date' button induces date-picker screen to choose the operation day. The 'Coronary Map' button allows users to record the stenting data on the coronary artery system while selecting a coronary location by the AHA-number in the coronary map (Figure 3). The user touches a location number on the screen, looks at coronary intervention list view for the location, and selects appropriate procedures (Figure 4). After inputting all the intervention results on record, the user returns to the edit page (Figure 5). Finally confirming the operation date and the

coronary intervention details again, the screen will return to the main view with the newly recorded information (Figure 6, 7). The time-series record about of PCI data can be accessed anytime and anywhere in the world. Figures from 1 to 7 have showed example views on iOS.

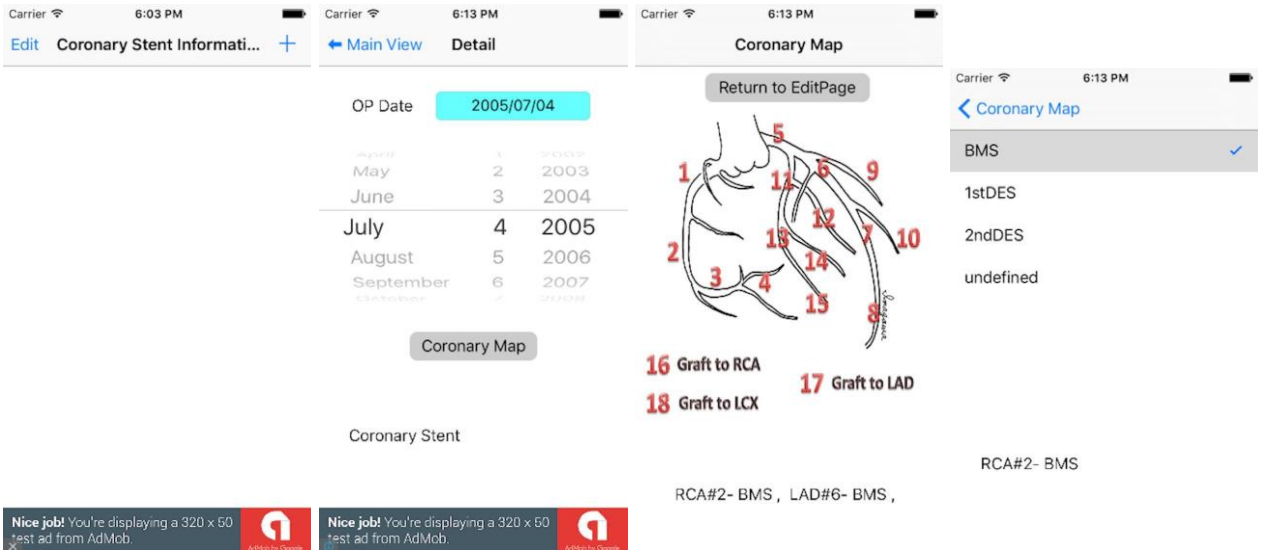

Figure 1, 2, 3, 4: *"Coronary Stent Information" for iPhone*

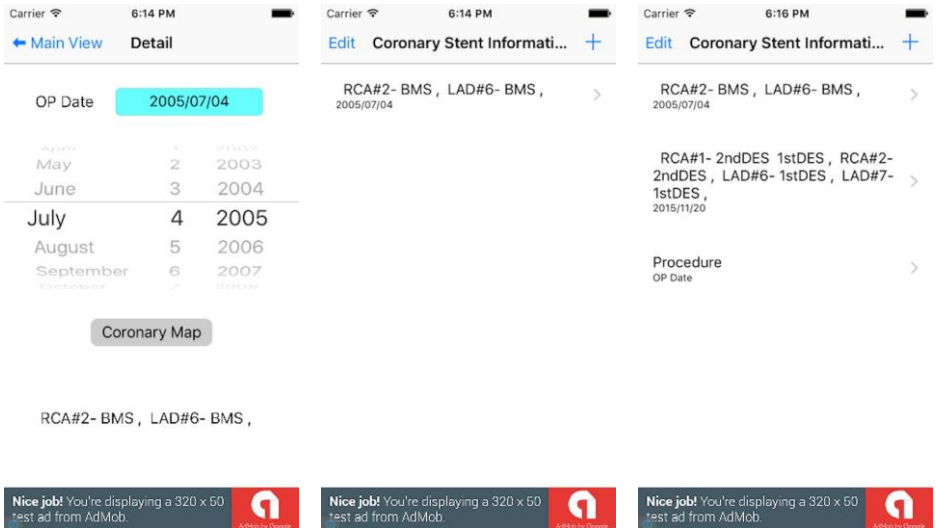

Figure 5, 6, 7: "*Coronary Stent Information" for iPhone*

3.2 Prosthetic Heart Valve Information

The "Prosthetic Heart Valve Information" is developed as a smartphone application designed to save the heart valve implantation operation summary. The operative data includes the surgery date, the valve position and type of the artificial prosthesis, such as mechanical, bioprosthetic and undefined. Scenes of android version were demonstrated Figures from 8 to 10.

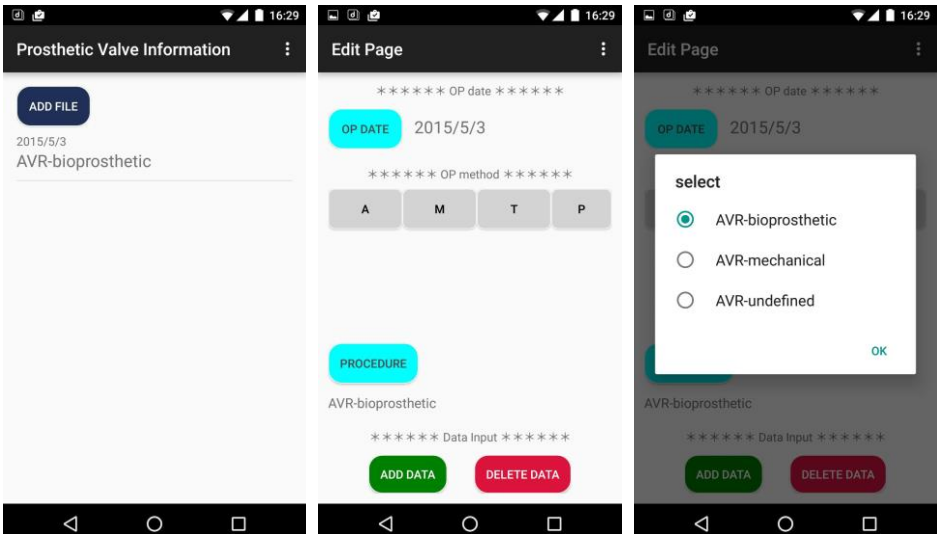

Figure 8, 9, 10: "*Prosthetic Heart Valve Information" for android*

4. Results

To evaluate application users' satisfaction, PCI patients and cardiologists were asked to use the developed "Coronary Stent Information" and then assessed their subjective satisfactory level to identify the appropriateness and usefulness of the application. The mean age of participants was 67 ± 10 years (range, 41−73 years), and women accounted for 20%. Ninety percent of the users answered that they were satisfied with the composition, design, layout, and usefulness of the application. Feasibility and usefulness of "Prosthetic Valve Information" were evaluated by volunteer patients and cardiac surgeons. The mean age of participants was 69 ± 8 years (range, 60−74 years), and women accounted for 10%. A self-reported questionnaire was distributed to volunteer people at the outpatient clinic. Eighty percent of prosthetic valve

implanted patients satisfied with and the 80% of cardiac surgeons espoused this application.
All participants were able to complete an application within several minutes, and all clinical information was comprehended by all the users. The data will be lost when the user uninstalls the program or the application data is cleared through the settings.

5. Discussion

Coronary stents and adjunctive pharmacologic agents have improved the results of PCI in early and late postoperative period in the vast majority of patients, unless the patients continue taking antiplatelet medications. Premature discontinuation of the dual antiplatelet therapy consisting of aspirin and a P2Y12 receptor inhibitor such as clopidogrel (PLAVIX®), prasugrel (EFFIENT®), or others, is the single greatest predictor of in-stent thrombosis. Incidentally, the replacement of malfunctioning heart valves with prosthetic counterparts has been an accepted routine clinical procedure for over sixty years. The cohort studies have revealed the comforting outcomes of mechanical and bioprosthetic valve implantation surgery when the postoperative anticoagulant medication is managed competently and appropriately.

There are two conditions, which may affect the prognosis of the above-mentioned cardiovascular post-treatment patients. The first is an unexpected emergency having communication barriers, which might pose problems of indispensable medication withdrawal. In unpredicted settings such as cerebrovascular disorder (Valgimigli, M., et al. 2014) or acute abdomen (Cheng, V. E., Oppermen, A., Natarajan, D., et al. 2014), the information about the type of PCI stent is usually hard to obtain because of onset of urgent pathological events. In these settings the needs to concentrate on treatment results in not enough attention paid to the data about the patient's underlying diseased condition. If a prosthetic valve patient was involved in an accident and furthermore the case was unable to communicate about their type of the artificial heart valve, mistakes would be made in accurately treating the patients and appropriate cures would be delayed.

The second issue is the aging in postoperative patients. Cardiovascular treatments are becoming less invasive and making better results. Therefore post-treatment patients are getting older throughout the world (Ai, A. L., Hopp, F., & Shearer, M. 2006) (Aramide, G., Shona, K., Keith, B., & Teresa, B. 2016) (Forman, D. E., & Alexander, K. P. 2016). To be senile is not only to have prolonged life but to get decreased ability in body and brain (Baars, J. (2016). Aged

patients may happen to forget or stop taking their indispensable medicines and nobody can criticize it. If medical crews or care staffs could notice a hidden medical condition, wrong decisions causing tragic consequences would be reduced. Those close to the patient certainly need some medical history messengers.

A complementary digital solution have offered additional advantages to not only information technology but public health (Olsson, S., Lymberis, A., & Whitehouse, D. 2004). For example, mobile phones have demonstrated the capacity to improve multiple aspects of communication medical practice, including mental health care (Cranwell, K., Polacsek, M., & Mccann, T. V. 2016). Ubiquitous system provided by the smartphone technology would be useful for the solution of some medical problems in the postoperative patients.

At emergency department visiting, it is so important for patients to inform the culprit symptoms as well as their underlying medical condition to a physician, though they are sometimes unconscious or unable to communicate. Some medical ID tags or cards have been pointed out their usefulness revealing a hidden medical condition (Neame, R). The majority agrees on the benefits of carrying important medical information, however some of staff indicated that it was not routine to search for items or to request additional information on the patient (Morton, L. 2002). In the initial treatment of critically-ill patients, they may search for contact address including cellphone, which might replace the medical history messenger in the future.

Smartphone-based health applications are becoming much more widely available. However, regulatory rules and security problems of smartphone medical applications are underdeveloped. Both patients and physicians thus need to familiarize themselves with the clinical and legal risks that applications may introduce (Hordern, V. 2016) (Al-Badarneh, A., Najadat, H., & Yabes', E '. 2017). It is requested to balance the increased need for personalized medicine and optimal medical management with limited security. Supporting patients in archiving the operation data and taking control of the medication management would guarantee the safety and improve the quality of their life. Further testing of the applications in larger cohorts and real-world settings are necessary.

6. Conclusion

Coronary stent and prosthetic heart valve data recording systems using smartphone technology are simple and valuable methods in managing people suffering from ischemic or valvular heart disease. Patients with coronary stents or prosthetic heart valve might have less possibility of lethal complication using these mobile data system. The ubiquitous applications would improve health-care quality of patients who have undergone percutaneous coronary intervention and prosthetic heart valve surgery in the future.

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