Original Article

Modern use of smartphone applications in the perioperative management in microsurgical breast reconstruction

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Background: Advances in mobile telecommunication, improved mobile internet and affordability have led to a significant increase in smartphone use within medicine. The capability of instant messaging, photography, videography, word processing, drawing and internet access allow significant potential in this small portable device. Smartphone use within medicine has grown tremendously worldwide given its affordability, improved internet and capabilities.

Methods: We have searched for apps specifically helpful in the perioperative care of microsurgical breast reconstructive patients.

Results: The useful apps have been subdivided: (I) communication apps—multimedia messaging, WhatsApp, PicSafeMedi: allow efficient communication via text, picture and video messages leading to earlier assessment and definitive management of free flaps; (II) storage apps—Notability, Elogbook: electronic storage of patient notes and logbooks of case which can be shared with others if required; (III) educational apps—FlapApp, Touch Surgery, PubMed on tap: step by step guides to surgical procedures to aid learning and medical journal database; (IV) flap monitoring app—SilpaRamanitor: free flap monitoring app based on photographic analysis for earlier detection of compromised flaps.

Conclusions: There has been remarkable growth in smartphones use among surgeons. Apps are being developed for every conceivable use. The future will be in wearable smart devices that allow continuous monitoring with the potential to instigate change should deviations from the norm occur. The smart watch is the start of this digital revolution.

Keywords: Smartphone; iPhone; Android; app; microsurgical; breast reconstruction; free flap

Submitted Jan 10, 2016. Accepted for publication Jan 25, 2016.
doi: 10.3978/j.issn.2227-684X.2016.02.02
View this article at: http://dx.doi.org/10.3978/j.issn.2227-684X.2016.02.02

Introduction

Advances in mobile telecommunication, improved mobile internet and affordability have led to a significant increase in smartphone use within medicine. The capability of instant messaging, photography, videography, word processing, drawing and internet access allow significant potential in this small portable device (1).

Smartphones were first created in 2001 by Palm, but 6 years later revolutionized by the Apple iPhone and its intuitive user experience. Google soon created its own operating system, Android. Both systems have their

Table 1 Summary of useful apps for a breast reconstructive microsurgeon

Category	App	Description	Cost
Communication	Picture Messaging (iMessage; WhatsApp)	Text, photo and video messaging service to one or more users. Some caution should be applied, as this is not an encrypted method of transfer	WhatsApp free for first year and then £0.69 per annum (for both Apple and Android) i-message, however, is iOS only
	PicSafeMedi	Securely take, transmit and store patient consented clinical photographs. There are three levels of consent—records, research and publications	Free basic version. Pro version costing £39.99/year
Storage	Notability	Allows you to record information using text, drawing, photos and transfer via email or to a remote desktop	£2.29
	Elogbook	Electronic logbook of operations can be stored and later transferred onto the online website	Free app but access to ISCP is £125 per annum
Educational	Touch Surgery	Mobile surgical simulator that allows the user to learn by performing the operation	Free
	FlapApp	Educational tool to breakdown the surgical steps of an operation	Free
	PubMed on tap	Search PubMed database to find and display reference information and associated pdfs, which can be downloaded to a searchable internal library	Free lite version. Full version costing £2.49
Flap monitor	SilpaRamanitor	Free flap monitoring app on the Android OS. Currently being updated and will be available on both	Currently unavailable

independent 'app store', allowing the user to download worthwhile smartphone applications ('apps'). During this time rates of microsurgical breast reconstruction has continued to rise. This paper focuses on beneficial apps that can be utilized for the perioperative management in microsurgical breast reconstruction (2).

Methods

Useful apps where identified by surveying interested surgeons and search the Android and Apple IOS app stores.

Results

The apps useful in perioperative microsurgical breast reconstruction have been subdivided into those related to communication, storage, education and flap monitoring (*Table 1*).

Efficient communication

Time is of significant importance for successful salvage of microsurgical breast reconstruction. There are a number of apps that allow for instant communication between team members, from sending basic text messages to more advanced pictures or even video messages; these include Multimedia Messaging, WhatsApp and PicSafeMedi (3).

Knobloch, 2009 explains that the mobile phone based multimedia messaging service is accurate in transferring a more comprehensive impression of the postoperative flap assessment. The authors also comment on being able to commence earlier definitive management in the form of medical leeching for venous congestion (4).

In a comprehensive review of 123 free flaps, the use of multimedia messaging in the early postoperative period lead to reduce the time to re-exploration from 4.0 to 1.4 hours with resulting flap salvage from 50% to 100% (5). A similar study showed a significant difference for time to re-assessment from 180 to 8 minutes with remote smartphone photography (6). The overall accuracy of photography was comparable to in-person assessment, 97.4% compared to 98.7%, respectively.

A relatively unexplored area has been the use of multimedia messaging between breast reconstructive patients and surgeons in the perioperative period. Rao and colleagues demonstrated reduced number of clinic visits,

fewer overall days of drain requirement, and increased efficiency of clinic visits with this system (7).

Storage

Patient data can be stored on numerous apps; however, the Elogbook is a secure method of capturing patient operative details, which can be later transferred to the online site. Other apps such has Notability allow electronic record keeping with written and drawn information, photographs and typed text to be stored and transferred between health care individuals. We are exploring the use of such apps for our perioperative notes and planning for each breast reconstructive patient (see *Figures 1–3*).

Education

There are several apps that assist the user to learning how to undertake microsurgical breast reconstruction. Touch Surgery and FlapApp are two such apps that help the user appreciate the operative steps by breaking down the entire operation into smaller steps. Touch Surgery follows the surgical mantra, "the decision comes before the incision". It is an interactive surgical simulator and allows the user to undertake the operation within its realistic surgical environments created with state-of-the-art 3D graphics. It allows the users to 'test' their knowledge and track their progress. FlapApp focuses on educating the user about potential patients that may be appropriate for the selected breast reconstruction, highlights the operative steps with clinical images and drawings.

PubMed on tap is a free search engine of medical journals that allows the user to rapidly access the latest published literature. It will and makes it easily accessible to the mobile user.

Flap monitoring

SilpaRamanitor is a free flap monitoring app that uses smartphone technology. It has been developed for Android operating system and is effective in demonstrating tissue perfusion. The smartphone is used with a specifically created white open box made of cardboard to standardized white balance and camera-to-object distance. The model was initially developed using healthy volunteers and experimentally setting up finger tourniquet to creating varying degrees of arterial and venous occlusion. The sensitivity, specificity, false-negative results, and false positive results were 94%, 98%, 95% and 1%, respectively, which is comparable to clinical monitoring. Its first trial in a clinical setting was a women undergoing breast reconstruction with a free transverse abdominis musculocutaneous flap after modified radial mastectomy. The monitor was used every hour, and detected partial venous occlusion at 8 hours that was not clinically apparent. An hour later, the flap was visually darker and venous blood was present using skin prick test. The flap was successfully salvaged. This suggested that the app could detect slight venous issues well ahead of clinical observation, which is important to expedite successful flap salvage (8). The authors are currently working on an upgraded version of the app, which will also be available on Apple's operating system, iOS.

Discussion

There has been remarkable growth in the acceptance and use of smartphones among surgeons with apps being developed for every conceivable use but relative to other specialties there are fewer plastic surgery specific apps (9,10). Needless to say, several authors have highlighted a number of general apps that could be used by the specialty (1,11-14). Freshwater in 2011 described the smartphone as an ectopic brain (1). However we feel that the smartphone is much more than this; it allowing rapid and effective communication between individuals, and there are apps in development that may even help in early detection of flap compromise.

Although, the benefits of smartphone apps to a microsurgical breast reconstructive surgeon are evident, the issue of confidentiality, consent, storage and retention warrants attention (14-17). There must be some caution with regards to storing and transferring patient sensitive data. There are both ethical and legal factors when processing this type of data and although, guidance varies between countries, the Data Protection Act [1998] from the UK and the Health Insurance Portability and Accountability Act of 1996 (USA) both form robust frameworks (13). Recent healthcare legislative changes to the Australian privacy act took effect in March 2014. Under these changes to federal law, health professionals with unsecured patient images on their smart devices will face fines up to $340,000 and institutions up to $1,700,000 for a breach of patient privacy (16).

A clinical smartphone application, and collected data, used for patient care is likely to be considered part of a

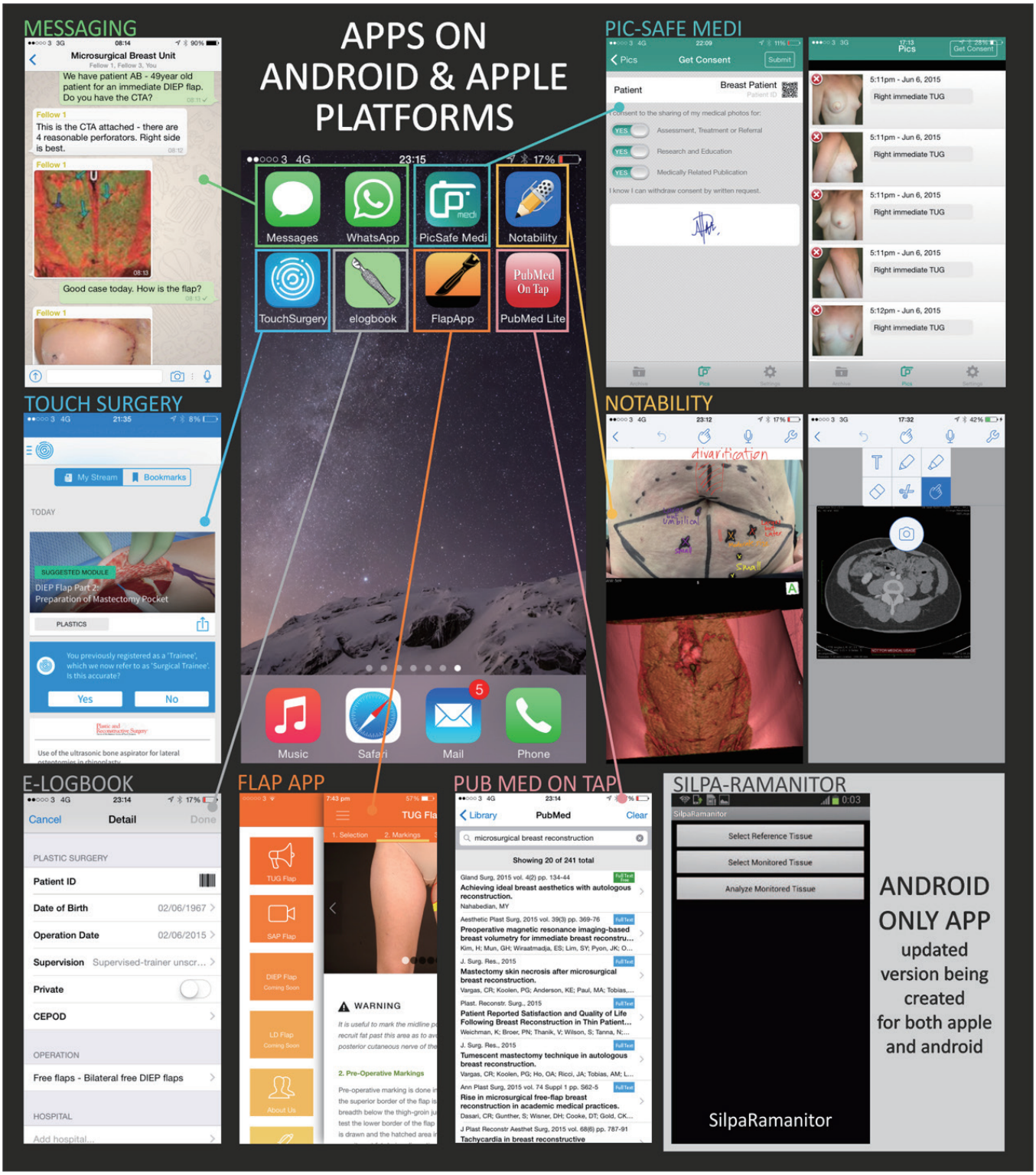

Figure 1 Useful smartphone apps for microsurgical breast reconstruction with sample screenshots.

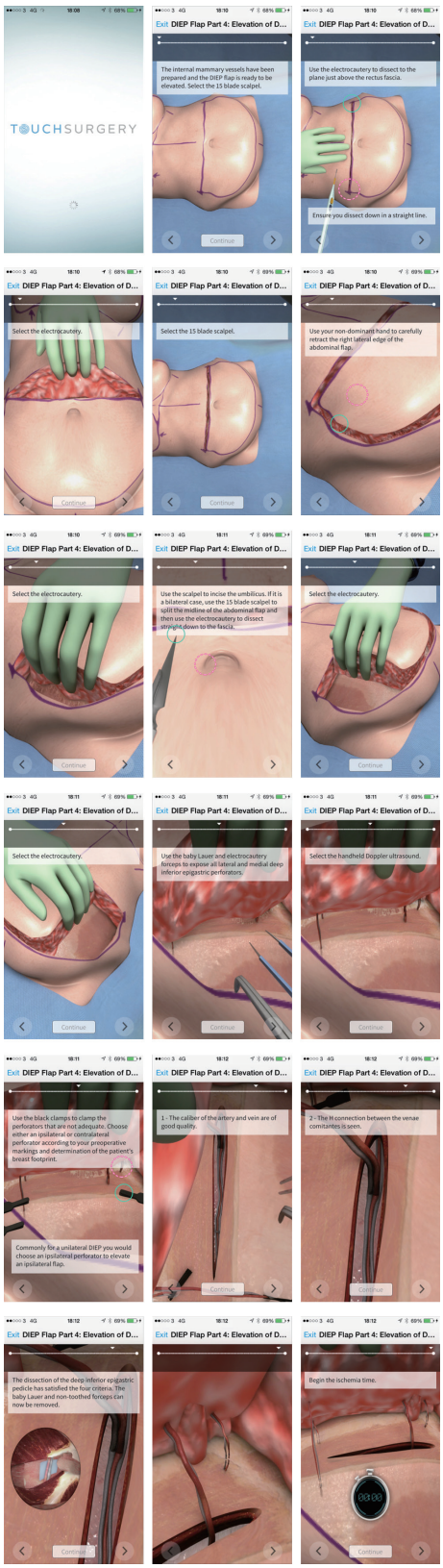

Figure 2 Touch Surgery app screen shots showing the steps of performing a TUG flap.

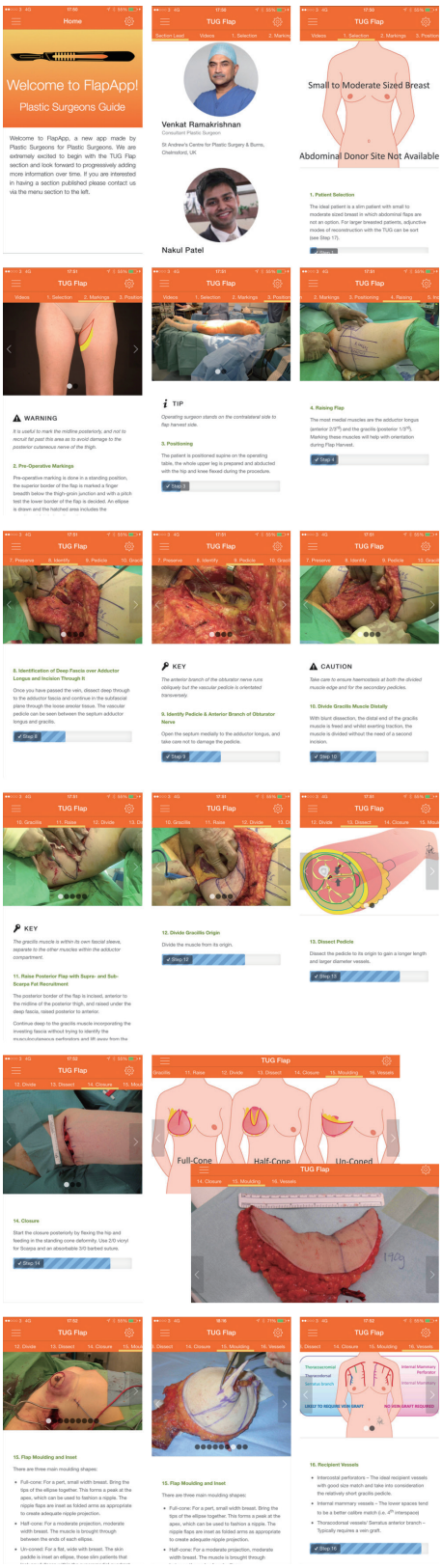

Figure 3 FlapApp screen shots showing the steps of raising a DIEP flap.

patient's medical record, even when stored electronically. Doctors should be aware of the applicable health records legislation within the country in which they practice. In addition, it is usual for local freedom of information legislation to give patients access their own clinical photographs if and when requested.

The ultimate responsibility for the use of smartphone applications; patient consent, storage and sharing of data will rest with the individual doctor and employing organizations however, Elogbook and PicMediSafe have secure methods of storing patient data and the latter can help choose levels of consent prior to taking photographs.

The benefits of the smartphone to the microsurgical breast surgeon are in their infancy and it is certain that there will be an exponential rise in the number and range of differing and valuable apps available on the market. The use of these apps must be balanced against the need for clinicians to respect patient privacy, as the primary function in a professional environment is to deliver quality clinical care to patients within our ethical and legal responsibilities.

Conclusions

The future direction of smart devices and wearable is enormous, with new products being developed each day. Apple and many other companies have launched 'smart watches' that link to the user's smartphone. It is envisaged that these new devices will change communication, healthcare and clinic research.

Acknowledgements

The authors thank Jean Nehme and Andre Chow (co-founders of Touch Surgery) for showing the authors their lab and explaining future developments of their company and also thank Kidakorn Kiranantawat (inventor of SilpaRamanitor) for his personal communication about the next version of his app.

Footnote

Conflicts of Interest: NG Patel, T Vickers, L Khan, WM Rozen and VV Ramakrishnan were involved with the development of the FlapApp. DJ Hunter-Smith was involved with the development of the PicsafeMedi application. The other authors have no conflicts of interest to declare.

References

1. Freshwater MF. iPhone and iPad applications for plastic surgeons. J Plast Reconstr Aesthet Surg 2011;64:1397-9.
2. Dasari CR, Gunther S, Wisner DH, et al. Rise in microsurgical free-flap breast reconstruction in academic medical practices. Ann Plast Surg 2015;74 Suppl 1:S62-5.
3. Wani SA, Rabah SM, Alfadil S, et al. Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. Indian J Plast Surg 2013;46:502-5.
4. Knobloch K, Gohritz A, Vogt PM. Cell phone-based multimedia messaging service in reconstructive microsurgery: a novel telemedicine application. Plast Reconstr Surg 2009;123:220e-2e.
5. Hwang JH, Mun GH. An evolution of communication in postoperative free flap monitoring: using a smartphone and mobile messenger application. Plast Reconstr Surg 2012;130:125-9.
6. Engel H, Huang JJ, Tsao CK, et al. Remote real-time monitoring of free flaps via smartphone photography and 3G wireless Internet: a prospective study evidencing diagnostic accuracy. Microsurgery 2011;31:589-95.
7. Rao R, Shukla BM, Saint-Cyr M, et al. Take two and text me in the morning: optimizing clinical time with a short messaging system. Plast Reconstr Surg 2012;130:44-9.
8. Kiranantawat K, Sitpahul N, Taeprasartsit P, et al. The first Smartphone application for microsurgery monitoring: SilpaRamanitor. Plast Reconstr Surg 2014;134:130-9.
9. Mohan AT, Branford OA. iGuide to plastic surgery: iPhone apps, the plastic surgeon, and the health care environment. Aesthet Surg J 2012;32:653-8.
10. Amin K. Smartphone applications for the plastic surgery trainee. J Plast Reconstr Aesthet Surg 2011;64:1255-7.
11. Amin K, Edmonds K, Abboudi H, et al. Smartphone applications for the plastic surgeon: an update of Google's Android operating system. J Plast Reconstr Aesthet Surg 2012;65:1440-2.
12. Molajo A, Vaiude P, Benson A. 'iReconstruct': clinically relevant plastic surgery apps. J Plast Reconstr Aesthet Surg 2012;65:838-9.
13. Al-Hadithy N, Ghosh S. Smartphones and the plastic surgeon. J Plast Reconstr Aesthet Surg 2013;66:e155-61.
14. Hunter T, Hardwicke J, Rayatt S. The smart phone: an indispensable tool for the plastic surgeon? J Plast Reconstr Aesthet Surg 2010;63:e426-7.
15. Gardiner S, Hartzell TL. Telemedicine and plastic surgery: a review of its applications, limitations and legal pitfalls. J

Plast Reconstr Aesthet Surg 2012;65:e47-53.
16. Haynes CL, Cook GA, Jones MA. Legal and ethical considerations in processing patient-identifiable data without patient consent: lessons learnt from developing a disease register. J Med Ethics 2007;33:302-7.
17. Kirk M, Hunter-Smith SR, Smith K, et al. The role of smartphones in the recording and dissemination of medical images. J Mob Technol Med 2014;3:40-5.

Cite this article as: Patel NG, Rozen WM, Marsh D, Chow WT, Vickers T, Khan L, Miller GS, Hunter-Smith DJ, Ramakrishnan VV. Modern use of smartphone applications in the perioperative management in microsurgical breast reconstruction. Gland Surg 2016;5(2):150-157. doi: 10.3978/j.issn.2227-684X.2016.02.02

