Original Article

Using WhatsApp Smartphone Application to Monitor INR in Patients on Warfarin: First Experience with 21 patients.

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Abstract

Anticoagulation with warfarin is under-prescribed in eligible patients. The quality of anticoagulation as measured by Time in Therapeutic Range (TTR) is below the 60-70% standard in clinical practice (outside anticoagulation clinics) with lower rates in Sub-Saharan Africa when compared with Western Europe, Canada and the United States. WhatsApp is a free smartphone application that is increasingly used for telemedicine applications. In this retrospective study, we reviewed the use of WhatsApp for physician-patient communication of INR results and Warfarin dose adjustments. From March 5th, 2018 to May 15th, 2019, all patients (n=938) attending a private Cardiology clinic were offered WhatsApp as a means of direct communication with the Cardiologist on an as needed basis. 21 (2.2%) used it for INR reporting and Warfarin dose adjustment. The median age was 62 years, with a male to female ration of 10:11. The median TTR was 37% by Linear Interpolation, and 42.9% by percentage of therapeutic INRs. The median follow-up duration was 82 days. 23% of patients managed to achieve TTR of more than 72%. Most patients (61.9%) continued on warfarin during the study period, 9.5% switched to a Directly Acting Oral Anticoagulant, 9.5% stopped Warfarin due to bleeding while on therapeutic INR, 14.2% switched to another provider for INR monitoring, 9.5% were lost to follow-up. Smartphone technology may provide a solution for reduced Warfarin prescription for eligible patients, with some patients (23% in this study) achieving TTRs of more than 72%. However, overall TTR rates remained low in this study.

Introduction:

Anticoagulation with Warfarin is proven to prevent thrombotic complications in patients with atrial fibrillation, prosthetic heart valves, deep vein thrombosis, pulmonary embolism and antiphospholipid syndrome. Warfarin is under-prescribed in patients with non-valvular Atrial fibrillation ; in one study, 47% of patient admitted with ischemic stroke had previously diagnosed atrial fibrillation that was not appropriately treated with warfarin[1]. Similarly, warfarin is under prescribed in Sub-Saharan Africa, with only 34.2% of eligible patients receiving it in a study from Cameroon[2].

Strict INR control is required to prevent bleeding complications from supra-therapeutic INR, and prevent thrombotic complications from sub-therapeutic INR[3-5]. The quality of INR control is measured by the percentage of Time in Therapeutic Range (TTR). This can be measured by either linear interpolation (assumes a linear increase or decrease between two consecutive INR measurements), also known as the Rosendaal method [6] or the percentage of therapeutic INR readings. A generally agreed upon standard for TTR is 60-70%[7]. In a large systematic review of 67 studies, TTR values ranged from 57% when done by community physicians, to 66% in randomized controlled trials and anticoagulation clinics to 72% when self-managed by patients [8]. Moreover, there is considerable global variation in TTR as demonstrated in a study of patients randomized to the warfarin arm of the ROCKET-AF trial which compared between rivaroxaban and warfarin in prevention of stroke from atrial fibrillation. In this study the mean individual patient TTR ranged from 39.5% in India to 66.6% in Western Europe; with Eastern Europe, East Asia, South Africa, Latin America, Canada/United States in between at 53.0%, 53.3%, 57.6%, 59% and 65.8% respectively [9]. In Sub-Saharan Africa, TTR values were lower at 30.8% in Botswana[10], 29% in Addis Ababa, Ethiopia[11], 25% in Cape town, South Africa[12]. In one study from a dedicated anticoagulation clinic in Ahmed Gasim Hospital in Khartoum, Sudan, the reported TTR as measured by percentage of therapeutic INR readings ranged from 51.5% to 68.3%[13].

Smartphones offer a unique tool to facilitate communication between physicians and patients. A Chinese study (n=30) of a smart phone application for

anticoagulation management with Warfarin demonstrated a TTR of 56.5% for all patients and 65.6% in the good compliance group; with an education of more than 6 years as the only independent predictor of good compliance[14]. The estimated penetration of mobile phones in Sudan reached 70% in 2017 according to data from the World Bank[15], while Smartphone penetration is estimated at 19.7%[16]. WhatsApp is a free smartphone application for one to one or group messaging. Its main features are simplicity, reliability across weaker internet connections, and relative security when compared to other applications. By the end of 2017, WhatsApp had 1.5 billion active monthly users globally [17]. This has been associated with its' increased use in telemedicine [18]. It would be foreseeable that using WhatsApp for physician-patient communication may improve prescription of Warfarin to patients who are eligible, and perhaps even improve TTR and hence improve patient outcomes.

Methods:

All Patients attending a Cardiology Clinic were given the option of using WhatsApp for direct communication with the Cardiologist on an as needed basis. Patients on Warfarin used the application for INR monitoring and Warfarin dose adjustment as outlined in Figure 1.

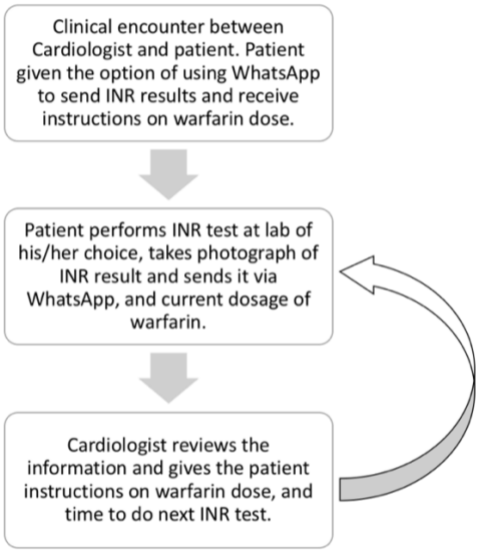

Figure 1. Process for Warfarin dose adjustment using WhatsApp

Retrospective review of WhatsApp "chats" (written communication) archive from March 5th, 2018 (first patient communication using the application) to May 15th, 2019 was performed. Demographic and clinical information was obtained from the clinic's electronic medical record. INR results were obtained from the WhatsApp chats archive. TTR & follow up duration was calculated using both Linear Interpolation method and percentage of therapeutic INR readings from a pre-designed

template downloaded from the link (http://www.healthcaresystemsolutions.com/index.php/downloads/excel-template-for-rosendaal-method-time-in-therapeutic-range-calculations/) . A template was created for each patient and dates and values of INR readings were entered. The application then automatically generated the TTR (using both linear interpolation method and percentage of therapeutic INR readings) and follow up duration. Patient outcome was obtained from the WhatsApp Chats archive &/or the Electronic Medical Record. "Lost to follow up" was defined as more than 3months since last INR check &/or clinical encounter.

Results

N=938 patients registered in the clinic's electronic medical record. N=272 (28.9%) patients communicated via WhatsApp. N=21 (2.2%) patients communicated via WhatsApp for INR monitoring and Warfarin dose adjustment. Average/Median Age was 64/62, with a range from 38-90 years. Male to Female Ratio was 10:11. Patient characteristics are summarized in Tables 1, 2 & 3.

Patient Location	No.	%
Khartoum	10	47.6%
Darfur/Kordofan Region	3	14.3%
Central Region (Sennar, Gezira States)	3	14.3%
Eastern Region (Gedarif, Kassala States)	2	9.5%
Northern Region (Northern State)	1	4.8%
Republic of South Sudan	1	4.8%
State of Eriteria	1	4.8%
Total	**21**	**100%**

Table 1. Patient Location

Indication	No.	%
Atrial fibrillation	11	52.3%
Rheumatic Mitral Stenosis	1	4.8%
Mechanical Mitral Valve	1	4.8%
Nonvalvular	9	42.8%
Left ventricular thrombus	8	38.1%
Pulmonary Embolism	1	4.8%
Deep Vein Thrombosis	1	4.8%
Total	**21**	**100%**

Table 2. Indication for Anticoagulation

Type of Initiation	No.	%
New Prescription	17	80.9%
Patient switched from a different provider	3	14.3%
Patient switched from DOAC (Directly Acting Oral Anticoagulant)	1	4.8%
Total	**21**	**100%**

Table 3. Type of Initiation of Anticoagulation

For patients with Nonvalvular Atrial fibrillation, the average(median) CHADS2Vasc score was 2.9 & 3, with a range of 1 to 5. 2 patients had CHADS2Vasc score of 1. The decision to anticoagulate for one patient was due to congestive heart failure with low ejection fraction; for the other patient, the indication was a female patient with a markedly dilated left atrium. TTR

TTR data was obtainable from 17 patients, 2 patients switched to other provider with only one INR reading sent via WhatsApp, 2 patients had just initiated Warfarin and had only one reading at time of retrospective review. The TTR findings are summarized in Table 4 & Figure 2. The outcomes of anticoagulation are summarized in Table 5.

Variable	Average/Median	Range
TTR by linear interpolation	45% (37%)	12.3-100%
TTR by percentage therapeutic INR readings	44% (42.9%)	0-100%
Follow Up Duration in days	122 (82)	18-394

Table 4. TTR Results

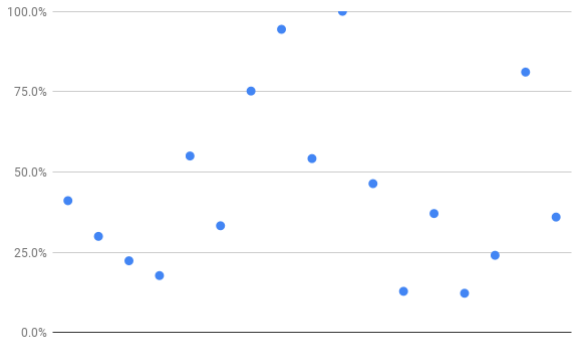

Figure 2. Scatter Plot of Individual Patient TTR

Outcome	No.	%
Ongoing	12	57.1%
Switched to DOAC	2	9.5%
Lost to Follow Up*	2	9.5%
Stopped Due to Bleeding while therapeutic range INR	2	9.5%
Switched to a Different Provider for INR monitoring	3	14.3%
Total	**21**	**100.00%**

Table 5. Outcome of Anticoagulation

Discussion

To the best of our knowledge, this is the first study that utilized WhatsApp for the purpose of INR monitoring and warfarin dose adjustment. The main advantages of using WhatsApp from this study is the ability to achieve >90% follow up rate for all patients prescribed warfarin. This would be of special value to patients living outside Khartoum, who would be less likely to get warfarin prescribed in Khartoum due to concerns

about adequate follow up. Moreover, using WhatsApp actively engages patients in INR monitoring, and some patients (23%) are able to achieve TTRs of more than 75%; a rate exceeding that of clinical trials and similar to self-managed patients. In addition, WhatsApp enables the physician to manage warfarin related complications (in this study, 2 patients developed bleeding with therapeutic range INR) promptly. Perhaps, the most important advantage of using WhatsApp is reduction of the cost of care; as patients don't need to travel to an anticoagulation clinic or return to the physician for warfarin dose adjustment. This is an important endpoint in low resource settings.

WhatsApp for INR monitoring has its' limitations, the mean TTR value for all patients remained suboptimal in this study, below the accepted international standard of 60-70%; albeit better than other studies from sub-Saharan Africa. The patients in this study all attended a private clinic, hence the study may be biased towards patients with higher socioeconomic status, and as a result more likely to own a smartphone and be familiar with WhatsApp usage. Furthermore, WhatsApp is limited to one to one communication which reduces applicability to group practices with more than one physician. It also relies heavily on simultaneous patient and physician engagement; which may not be available in all settings.

Given the above, we believe that smartphone technology can be of value for certain patients to improve Warfarin prescription rates and TTR rates in certain patients and in a private practice setting. One thing to consider would be designing and implementing a dedicated smartphone application with automated algorithms to guide the physician (a strategy that is proven to improve TTR[19]) & notifications to remind patients to get INR checks.

Conclusion

Smartphone technology may have a role in increasing Warfarin prescription rates with acceptable follow-up rate in certain settings. TTR rates remain low, and additional solutions are needed to improve it.

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