



Research Article

Knowledge, Attitudes, and Practices of Prescribing Doctors Towards Direct Oral Anticoagulants: First Cross-sectional Study from Sudan

Toga K. Mohamed¹, Bashir A. Yousef^{2,3}, Abdalla O. Elkhawad⁴, Kannan O. Ahmed^{5,6*}

¹Department of Clinical Pharmacy, Faculty of Pharmacy, University of Medical Sciences and Technology, Khartoum, Sudan

²Department of Clinical Pharmacy and Pharmacology, Ibn Sina National College for Medical Studies, Jeddah, Saudi Arabia

³Department of Pharmacology, Faculty of Pharmacy, University of Khartoum, Khartoum, Sudan

⁴Department of Pharmacology, Faculty of Pharmacy, University of Medical Sciences and Technology, Khartoum, Sudan

⁵Department of Pharmacy Practice and Training, College of Pharmacy, National University of Science and Technology, Muscat, Oman

⁶Department of Clinical Pharmacy and Pharmacy Practice, Faculty of Pharmacy, University of Gezira, Wad Medani, Sudan

Corresponding Author: Kannan

O. Ahmed; email:

omerkannan@gmail.com

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Seid Ahmed Husain, MD, M.Sc.,

MHPE, PhD.

Abstract

Background: During recent years, the prescription rates of direct oral anticoagulants (DOACs) have increased rapidly worldwide. Little is known about the situation of DOACs in Sudan. Therefore, this study was conducted to assess prescribing doctors' knowledge, attitude, and practice level regarding DOACs.

Methods: A cross-sectional, hospital-based study was conducted at three large hospitals in Khartoum, Sudan. The doctors were recruited from a wide range of disciplines such as cardiology, surgery, and nephrology. A four-section questionnaire consisting of questions on demographics, knowledge, attitude, and practice was designed and administered.

Results: A total of 100 doctors responded over a period of four months, 52% of them were found to correlate with a low level of knowledge. Moreover, 56% and 81% of the doctors demonstrated inappropriate attitude and practice levels, respectively. With regard to switching protocols between DOACs and warfarin, the majority of the doctors did not have sufficient information when converting from rivaroxaban to warfarin and vice versa.

Conclusion: The overall knowledge, attitudes, and practices of prescribing doctors regarding the use of the DOACs were found to be inadequate and insufficient for maintaining high therapeutic outcomes in patients necessitating anticoagulants agents. A well-structured educational program about DOACs is urgently needed.

Keywords: doctors, knowledge, attitude, practice, direct oral anticoagulant, Sudan



1. Introduction

The utilization and prescription rates of direct oral anticoagulants (DOACs) have been increasing exponentially on a worldwide basis since the Food and Drug Administration (FDA) approval of the first DOACs in 2010 [1]. This is hugely attributed to the benefits of using DOACs when compared to the conventional Vitamin K antagonist warfarin. Dabigatran, a direct thrombin inhibitor, was approved by the FDA in 2010. It has established its place as a major anticoagulant agent and was found to be non-inferior to warfarin in a meta-analysis study [2]. It was subsequently followed by the introduction of Factor Xa inhibitors, namely rivaroxaban, edoxaban, and apixaban.

Dabigatran, rivaroxaban, edoxaban, and apixaban gained approval for use mainly in stroke prevention in patients with non-valvular atrial fibrillation. Additionally, those agents were also found to be beneficial in the setting of deep vein thrombosis and pulmonary embolism prevention and treatment [3]. Likewise, rivaroxaban has also been approved in Europe for the prevention of atherothrombotic events following acute coronary syndrome (ACS) [4].

Considerable safety and efficacy profiles were demonstrated by a number of randomized clinical trials. For instance, the RE-LY trial compared high and low doses of dabigatran to warfarin. A reduction in stroke risk was noted with high-dose dabigatran 150 mg in comparison to warfarin with similar bleeding risk [5]. The ROCKET-AF trial was a noninferiority trial that compared rivaroxaban 20 mg with International Normalization Ratio (INR)-adjusted warfarin and revealed that rivaroxaban was as effective as warfarin for thromboprophylaxis in NVAF [6]. The Advance 2 Trial provided additional evidence concerning the efficacy of DOACs, as apixaban 2.5 mg was found to be more

effective in preventing VTE compared to once-daily enoxaparin without an increase in bleeding events [7]. Interestingly, DOACs do not require continuous monitoring and have had a lower bleeding tendency when compared to warfarin [8]. Additionally, DOACs offer predictable dosing regimens and fewer drug–drug and drug–food interactions [9].

It is important to note that certain patient-specific factors may limit the use of DOACs. For instance, DOACs have limited use for patients with renal and hepatic impairment, heightened bleeding tendencies, and pregnancy [10]. Moreover, the use of DOACs has been contraindicated in mechanical prosthetic valves and mitral valve stenosis. The RE-ALIGN trial, which investigated the use of dabigatran and warfarin in patients with mechanical heart valves, was terminated early due to excessive thromboembolic and bleeding events in those subjects. It concluded that dabigatran was contraindicated in such settings, making warfarin the drug of choice for those patients [11].

Knowledge about the DOACs dosing regimens, renal dosing adjustments, methods of administration, protocols for switching between different agents, management of adverse effects, and use of antidotes is critical for guiding positive therapeutic outcomes for patients. Thus, it is important to ensure that doctors are completely familiarized with these treatment strategies [12].

DOACs dosing regimens are variable and are based on several factors. The indications, patient risk factors, renal function, and creatinine clearance (CrCl) are known to play a major role in predefining the dose of DOACs [13]. Moreover, DOACs necessitate specific administration instructions that are integral to their therapeutic efficacy. Guidelines emphasize the importance of adhering to these protocols, whether taking the DOAC with or without food [14]. As an illustration, rivaroxaban

administration is dose-dependent, with higher doses (15 and 20 mg) recommended to be taken with food, while lower doses (2.5 and 10 mg) may be taken with or without food. Noncompliance with these instructions for rivaroxaban can increase the risk of thromboembolic events [15].

In clinical settings, multiple occasions exist where the transition between the different anticoagulant classes becomes a necessity. The guidelines continuously advise on switching protocols between different anticoagulants. According to the American Heart Association (AHA) guidelines, assessment of the drug's pharmacokinetic profile, pharmacodynamic profile, and renal function is important before transitioning between different anticoagulant classes [16]. In regard to adverse effects of DOACs, cases of severe or life-threatening bleeding are common and usually involve the use of reversal agents. For patients taking dabigatran, Idarucizumab is recommended to address life-threatening bleeding. Conversely, Andexanet alfa, a modified form of Factor Xa, is approved for use in emergencies involving severe bleeding to reverse the effects of rivaroxaban and edoxaban [17].

In Sudan, warfarin was the mainstay of anticoagulant therapy for a long time. However, the recent registration of rivaroxaban, and subsequently dabigatran, imposed a change in the prescribing pattern of anticoagulants. Over the past few years, the use of DOACs has increased dramatically for managing a variety of indications. However, no studies were conducted in Sudan to evaluate the knowledge and attitudes of the doctors or patients regarding DOACs. Therefore, this study aimed to evaluate the degree of knowledge and examine the doctors' attitudes and practices toward DOACs.

2. Materials and Methods

2.1. Study design, setting, and population

A cross-sectional hospital-based study was conducted at three large hospitals in Bahri locality of Khartoum, Sudan: (1) Bahri Teaching Hospital, which is a tertiary care governmental teaching hospital providing services in a wide range of medical disciplines; (2) Ahmed Gasim Hospital, which mainly offers cardiac and renal transplantation services with intensive care units (ICU) and coronary care unit (CCU) facilities and is considered one of the main cardiac centers in Sudan; and (3) Haj Al Safi Teaching Hospital, a multidisciplinary unit delivering a variety of services in internal medicine, obstetrics, and outpatient services. The study was carried out over a period of four months, from February 2022 to May 2022.

Eligible participants included all doctors working in a variety of different disciplines, including nephrology, cardiology, and internal medicine. All doctors who were registered by the Sudan Medical Council and could prescribe DOACs were included in the study. Health practitioners other than doctors were excluded from the study.

2.2. Sample size calculation

The sample size was calculated using the Cochran formula given that 100 doctors were enrolled in the study [18].

$$n = \frac{Z^2 P(1-P)}{e^2} / 1 + [Z^2 \times P(1-P) / e^2 N],$$

where Z = confidence interval; P = population proportion; e = margin of error; and N = population size.

The collective doctors' population size from the three targeted hospitals was 141 (N) doctors at the time of the study. Using a confidence interval of 95%, with a margin of error of 5% and a proportion of 50%, a sample size of 81 doctors was found to be

appropriate for the study. According to this formula, the calculated sample size was 103.

2.3. Validation

A questionnaire was developed and adapted from the literature [19, 20] and then sent to a consultant cardiologist, a neurologist, a clinical pharmacist, and a biostatistician to assess content suitability. They made several changes to make the questionnaire simpler and less time consuming. After that, a pilot study of 16 doctors was conducted at two different hospitals. Data attained from the pilot study were not involved in the final results. A Cronbach alpha value of 0.76 was obtained, affirming that it was a highly reliable questionnaire.

2.4. Data collection

Data were collected using a four-section self-administered questionnaire, primarily composed of doctors' demographics (gender, job title, years of experience, specialty, and the current level of education), knowledge, attitude, and practice sections. The knowledge section investigated general information regarding the indications, antidotes, and contraindications to the DOACs uses. A score of 1 was given for each "correct answer," and a score of 0 was given for a "wrong" or "I don't know" answer making 17 points the highest attainable score. For the purposes of this study, a cut-off point of 8 was used to distinguish between high and low level of doctor's knowledge.

Attitudes of the doctors regarding the use of DOACs were assessed through four questions with a three-point Likert scale for responses: (1) Is it important to determine baseline renal function before starting DOACs?; (2) Is it important to evaluate the INR and monitor it periodically when using DOACs?; (3) Is the history of bleeding an absolute contraindication to DOACs?; and (4) Is it

important to counsel patients about adherence to DOACs? A score of 3 and above correlated with "high" attitude level regarding the use of DOACs whereas a score of 2 or lower indicated a "low" attitude level.

Using a similar approach, four questions regarding switching protocol were used to identify the appropriateness of practice regarding the use of DOACs. As in the attitude section, a cut-off point was used to differentiate between high and low levels of practice. Similarly, the questions utilized a three-point Likert scale for responses. The questions were as follows: (1) Do you usually consider finding the CHA₂DS₂-VASc score in patients with Atrial Fibrillation requiring DOACs?; (2) For patients using rivaroxaban and having target INR above the therapeutic range, do you consider continuing with the prescribed dose of rivaroxaban?; (3) For patients with compromised renal function on dialysis, do you consider stopping the use of DOACs and start warfarin?; and (4) Is it a common practice for you to prescribe antiplatelet along with DOACs for those with compelling indications?

Familiarity with the DOACs switching protocol is necessary to improve patient outcomes [3]. Therefore, this section was also intended to assess the doctors' practice regarding switching between DOACs and the conventional warfarin.

2.5. Data analysis

The statistical analysis was performed by the IBM SPSS statistical package, version 23.0. The obtained data was presented as frequencies, percentages, and bar charts. The association between different variables was also determined using the Pearson Chi-square and cross-tabulation statistics. A P-value of <0.05 was considered statistically significant.

TABLE 1: Socio-demographic characteristics of the studied doctors ($n = 100$).

Socio-demographic characteristics	Number (Frequency %)
Gender	
Female	57 (57)
Male	43 (43)
Level of education	
Bachelor degree	68 (68)
Master degree	14 (14)
Doctoral degree	11 (11)
Other (postdoc or fellowship)	7 (7)
Job Title	
Resident	15 (15)
Medical officer	45 (45)
Registrar	20 (20)
Specialist	11 (11)
Consultant	9 (9)
Years of experience (yrs)	
<5	70 (70)
5–9	18 (18)
10–14	3 (3)
15–20	3 (3)
>20	6 (6)
Department	
Internal Medicine	40 (40)
Cardiology	1 (1)
Emergency	9 (9)
Intensive Care Unit (ICU)	2 (2)
Primary Care Physician	11 (11)
Nephrology	2 (2)
Surgery	35 (35)

3. Results

3.1. Participants and baseline characteristics

Out of the 103 distributed questionnaires, 100 were submitted (response rate = 97%). The majority of respondents were females (57%), whereas males were 43%. More than two-third (68%) of the participants had a bachelor's degree, 11% of them had doctoral degree, and only 7% acquired other degrees such as fellowships. Taking the doctor's

job title into account, 45% were medical officers, 20% were registrars, 15% were residents, 11% were specialists, and only 9% were consultants. About 70% of the participants had <5 years of experience and only 6% had >20 years of experience. About 40% of the doctors were recruited from internal medicine, 35% from the surgery department, 11% were primary care doctors, 9% from the emergency department, and 2% from the ICU as shown in Table 1.

TABLE 2: Knowledge of doctors toward direct oral anticoagulants (DOACs) (n = 100).

Knowledge questions	Number (Frequency %)
Indications of DOACs	
Stroke prevention in NVAF	45 (45)
VTE in immobile/elderly	66 (66)
Thromboprophylaxis in orthopedic surgery	61 (61)
Thromboprophylaxis in mechanical heart valve	54 (54)
I don't know	9 (9)
Indications of warfarin	
Stroke prevention in NVAF	45 (45)
VTE in immobile/elderly	52 (52)
Thromboprophylaxis in orthopedic surgery	43 (43)
Thromboprophylaxis in mechanical heart valve	49 (49)
I don't know	6 (6)
Advantages of DOACs over warfarin	
No need to monitor INR	41 (41)
Wide availability	28 (28)
Low risk of bleeding	52 (52)
Lower cost	25 (25)
I don't know	22 (22)
DOACs known to have an antidote	
Dabigatran	5 (5)
Rivaroxaban	16 (16)
None of the above	23 (23)
I don't know	58 (58)
Contraindications against DOACs use	
Pregnancy/lactation	30 (30)
Stage 4 renal function (GFR = 15–30 ml/min)	43 (43)
Compromised liver function	44 (44)
I don't know	24 (24)

TABLE 3: Attitude of doctors toward direct oral anticoagulants (DOACs) (n = 100).

Attitude questions	Number of responses (%)		
	Disagree	Neutral	Agree
Prescribing of DOACs required baseline renal function	10 (10)	11 (11)	79 (79)
DOACs need INR monitoring	23 (23)	15 (15)	62 (62)
History of bleeding is an absolute contraindication	33 (33)	25 (25)	42 (42)
Counseling about DOACs	9 (9)	10 (10)	81 (81)

TABLE 4: Practice of doctors toward direct oral anticoagulants' (DOACs) use (n = 100).

Practice questions	Number of responses (%)		
	Disagree	Do not know	Agree
Computing CHA ₂ DS ₂ -VASC score	3 (3)	45 (45)	52 (52)
Rivaroxaban with INR above target	30 (30)	36 (36)	34 (34)
Switching DOACs to warfarin in renal impairment	25 (25)	38 (38)	37 (37)
Prescribing DOACs with antiplatelet	30 (30)	34 (34)	36 (36)
Switching practice questions			Number (Frequency %)
Switching from rivaroxaban to warfarin			
Continue rivaroxaban and start warfarin then slowly reduce the dose of the rivaroxaban			34 (34)
Stop rivaroxaban and start parenteral anticoagulants with warfarin			18 (18)
Stop rivaroxaban and start warfarin directly			8 (8)
Monitor and start the warfarin according to the pT/INR			11 (11)
I don't know			29 (29)
Switching from warfarin to rivaroxaban			
Continue warfarin and start rivaroxaban then slowly reduce the dose of the warfarin			20 (20)
Stop warfarin and start parenteral anticoagulants with rivaroxaban			12 (12)
Stop warfarin and start rivaroxaban directly			17 (17)
Monitor and start the rivaroxaban according to the pT/INR			9 (9)
I don't know			42 (42)

TABLE 5: Correlations between socio-demographic characteristics and overall knowledge, attitude and practice scores.

Variables		Number of responses		Number of responses		Number of responses	
		High knowledge	Low knowledge	High attitude	Low attitude	High practice	Low practice
Gender	Female	28	29	28	29	9	38
	Male	24	19	16	27	10	33
	P-value	0.507		0.235		0.346	
Level of education	Bachelor degree	34	34	25	43	14	54
	Master degree	10	4	8	6	1	13
	Doctoral degree	5	6	7	4	3	8
	Postdoc or fellowship	3	4	4	3	1	6
	P-value	0.449		0.2		0.576	
Job title	Resident	8	7	5	10	3	12
	Medical officer	24	21	18	27	9	36
	Registrar	9	11	11	9	3	17
	Specialist	6	5	5	6	4	7
	Consultant	5	4	5	4	0	9
	P-value	0.973		0.651		0.341	

TABLE 5: Correlations between socio-demographic characteristics and overall knowledge, attitude and practice scores.

Variables		Number of responses		Number of responses		Number of responses	
		High knowledge	Low knowledge	High attitude	Low attitude	High practice	Low practice
Years of experience (yrs)	≤5	35	35	30	40	14	56
	5–9	10	8	6	12	4	14
	10–14	3	0	3	0	0	3
	15–20	1	2	2	1	1	2
	>20	3	3	3	3	0	6
	P-value	0.493		0.249		0.613	
Specialty	Internal Medicine	22	18	20	20	7	33
	Cardiology	1	0	0	1	0	1
	Emergency	3	6	0	9	2	7
	ICU	1	1	1	1	2	0
	Primary Care Physician	7	4	10	1	4	7
	Nephrology	2	0	1	1	0	2
	Surgery	16	19	12	23	4	31
	P-value	0.503		0.003		0.041	

3.2. Doctors' knowledge about DOACs

Most doctors (52%) were found to have a high level of knowledge and 48% had low level of knowledge of DOACs (Figure 1(A)). Regarding the indications of DOACs and warfarin, the doctors were asked to choose the evidence-based therapeutic indications for these agents as shown in Table 2. Additionally, when asked about the advantages of DOACs over warfarin, 41% of the doctors stated that there is no need for INR monitoring, whereas 52% indicated that DOACs have lower bleeding tendency when compared to warfarin. The majority of the participants (58%) did not know about DOACs that can act as antidotes in the setting of bleeding. In regard to DOACs contraindications, most doctors knew that pregnancy, impaired renal and liver function limited the use of DOACs as shown in Table 2.

3.3. Doctors' attitude toward DOACs

As indicated in Figure 1(B), more than half (56%) of the doctors were found to have low attitude toward DOACs, while 44% attained a high attitude. Primarily, 79% of doctors agreed that it was important to determine the renal function baseline before initiating DOACs, whereas only 23% of the doctors knew it was not important to monitor the INR periodically while using DOACs. Of the 100 participants, about 33% of doctors knew that a history of bleeding may not present an absolute contraindication to DOACs. Additionally, 81% of doctors emphasized the importance of adequately counseling patients about the use of DOACs. The majority of the doctors were found to have a low level of attitude regarding the use of DOACs and 33% of the participants had a sufficient and proper attitude regarding DOACs (Table 3).

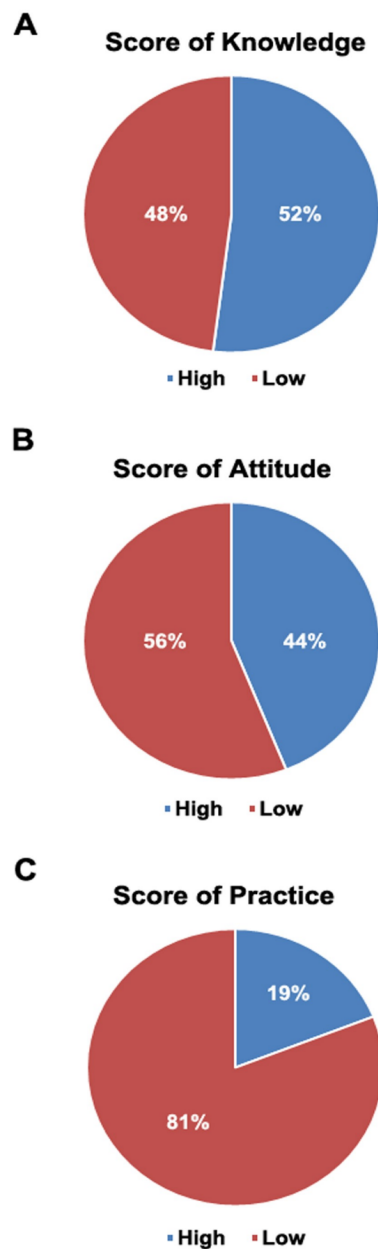


Figure 1: Overall knowledge, attitude and practice scores for the doctors towards direct oral anticoagulants (DOACs) (n = 100).

3.4. Doctors' practice toward DOACs

Figure 1(C) shows that 81% of doctors had a low level of practice regarding DOACs whereas only 19% achieved high practice levels. More than half (52%) of the doctors understood the importance of computing the CHA₂DS₂-VASC score prior to anticoagulant administration in atrial fibrillation patients. Over one-third (34%) of the doctors said

they will continue to use rivaroxaban in patients with INRs above the target range, 25% claimed that they would not consider switching DOACs to warfarin in the case of renal impairment, and 36% stated that they frequently prescribe DOACs with an antiplatelet as shown in Table 4.

The study also focused on analyzing the switching practice between anticoagulants. When asked about the conversion of rivaroxaban to

warfarin, only 18% demonstrated the correct switching protocol, which involves stopping rivaroxaban and starting parenteral anticoagulants along with warfarin. About 11% of doctors emphasized the importance of monitoring and switching according to the PT/INR. More than one-third (34%) of doctors would continue rivaroxaban and start warfarin, then slowly reduce the dose of rivaroxaban, which is not recommended as a practice. Additionally, 8% of doctors stated that they may stop rivaroxaban and start warfarin directly. Thus, the majority of doctors did not have adequate knowledge level regarding the switching protocol, and 29% had no idea about the switching protocol as shown in Table 4.

In switching from warfarin to rivaroxaban, many of the doctors (42%) did not know how to implement the switching protocol. Only 17% of doctors knew the importance of stopping warfarin and starting rivaroxaban directly, while only 9% emphasized the importance of monitoring the PT/INR when converting between warfarin and rivaroxaban (Table 4).

A correlation between the demographic characteristics and the knowledge, attitude, and practice variables was performed, and the results indicated that only specialty had a contributory role in the attitude (P-value 0.003) and practice (P-value 0.041) levels of doctors regarding the use of DOACs as presented in Table 5.

4. Discussion

Despite the surge in the utilization of DOACs for a multitude of indications and subsequent replacement of conventional warfarin, there seems to be a gap in the literature regarding doctors' DOAC knowledge and practice. In an attempt to fill the gap, we conducted the first study in Sudan at three large hospitals, in the Bahri locality, Khartoum. In the present study, the majority of the participants were females (57%). This was

found to be conflicting with the research conducted by Alnemari et al., which had a male majority (80.3%) [21]. Moreover, 45% of the participants were medical officers whereas consultants represented only 9% of participants. Furthermore, most of the participants were from the internal medicine (40%) and surgery departments (35%). Nearly 68% had a bachelor's degree, which was similar to Elbardissy et al.'s study where most physicians had a bachelor's degree (58.7%). About 70% had <5 years of experience, while in a contrasting research dataset, over half of the participants had >10 years' experience [19].

With respect to the doctors' knowledge, 52% of doctors had a score of eight and above, which signified a high knowledge level. This result was lower than a number of studies that evaluated the level of knowledge. For instance, Shasha et al. revealed that the level of knowledge about oral anticoagulant therapy for patients with NVAf among Chinese primary care doctors was insufficient in over half (75.8%) of the participants [20]. Moreover, it was concluded that the knowledge and behaviors of primary care doctors were insufficient for OAC therapy to prevent embolization in patients with NVAf. The study also revealed that despite the superiority of DOACs to conventional warfarin in NVAf, a significant gap regarding the DOACs knowledge within the Chinese primary care doctors was observed. Another notable study finding proposed by Siavash et al. shows that Canadian doctors have insufficient knowledge of dosing, administration, and patient counselling in the DOACs setting [22], and that this inconsistency might be due to the unavailability of international validated tools for DOACs.

As for doctor attitudes toward DOACs, the overall attitude was also found to be poor, with 56% of them obtaining a score of two and lower. Moreover, 79% of the doctors agreed on the importance of determining renal function prior to

the administration of the DOACs. The importance of determining the individuals' renal function to guide dosing and administration of DOACs was emphasized in several guidelines and studies, as in Patricia et al.'s study [23]. Only 23% of doctors indicated that INR monitoring was not compulsory and frequent while using DOACs, and 33% correctly stated that the history of bleeding might not be an absolute contraindication to DOACs. Although dabigatran and rivaroxaban were found to increase the risk of bleeding in a number of trials, the results were not conclusive as a number of patient-specific factors were found to affect and further increase the risk of gastrointestinal bleeding [24]. Thus, DOACs would still be indicated in such situations. Predictably, 81% of doctors emphasized the importance of providing adequate counseling to the patients regarding the use of DOACs. Attitude studies toward the DOACs have been conducted in a variety of settings. For instance, similar results were demonstrated by Nathan et al.'s study, where DOACs were not widely accepted by doctors for thromboembolic indications [25].

In the practice aspect, about 45% of doctors did not know the importance of computing the CHA_2DS_2 -VASC score before the initiation of DOACs. Keeping in mind that the main use of DOACs is stroke prevention in atrial fibrillation. A large number of doctors had no idea about the initiation protocol of DOACs in atrial fibrillation patients. Moreover, 34% of doctors agreed to continue the use of rivaroxaban in patients who have INR levels above the therapeutic range. Additionally, 37% claimed they may switch from DOACs to warfarin in the case of impaired renal function. Evidence from randomized clinical trials does not recommend the use of DOACs in patients with advanced renal impairment. Warfarin is the preferred anticoagulant agent in patients with low GFR values [26]. A total of 36% of doctors had no

problems in prescribing the DOACs along with the antiplatelet for those with compelling indications, initially in patients with concomitant atrial fibrillation and stent placement. This was proved in the WOEST landmark trial which supported the use of a two-drug antithrombotic regimen in concomitant AF and CHD patients, assuring optimal efficacy and reduced bleeding risk [27]. Furthermore, and following the PIONEER AF trial, which also studied combining rivaroxaban with antiplatelet, the FDA gave approval to the use of rivaroxaban 2.5 mg twice daily in coronary heart disease patients [28]. Overall, 81% of doctors were found to have inadequate practice levels when using DOACs.

Further investigation into the factors that may directly influence the doctors' knowledge, attitude, and practice toward the DOACs was conducted by correlating the doctors' demographics with the knowledge, attitude, and practice levels. Interestingly, doctors' specialty was found to have a significant impact in influencing the doctors' responses and attitude in the setting of DOACs. The doctor's practice was found to be associated with the specialty. In contrast to the results obtained by El-Bardissy et al., variables such as age, years of experience, and degree of education were found to significantly correlate with the physician awareness level toward DOACs. Whereas in the attitude section, factors such as gender, specialty, and job title were found to be associated with the doctors' attitude toward DOACs [19].

Familiarity with DOACs' switching protocol is necessary to improve patient outcomes [3]. A set of two questions were used to assess the doctors' knowledge in this area. Thus, upon conversion from rivaroxaban to warfarin, the guidelines recommend the cessation of rivaroxaban and starting low molecular weight heparin and warfarin, followed by the cessation of the low molecular weight heparin when INR is in the therapeutic range [29].

Only 18 out of the 100 doctors chose the correct switching procedure, and only 11 emphasized the fact that pT/ INR monitoring may be necessary upon conversion. The remaining majority of doctors either chose “incorrect” protocols or simply “did not know.” Another question also tested knowledge regarding the conversion of warfarin to rivaroxaban. The guidelines recommend stopping warfarin and starting the DOAC directly along with maintaining therapeutic monitoring of the pT/ INR [29], 17% of the doctors chose the right option regarding the conversion and 9% indicated the importance of pT/INR monitoring along with the process.

5. Conclusion

Despite the increasing rates of prescription of DOACs, the study concluded that the level of knowledge, attitudes, and practices of prescribing doctors is inadequate and insufficient for guiding the practice and therapeutic outcomes in patients requiring anticoagulation. Incorporation of comprehensive educational programs for doctors and determination of their proposed outcomes is urgently needed.

6. Limitations

Limitations to this study may include the confined geographical study area which may affect the generalizability of the data to the larger population. The study was conducted in Khartoum North, in the Bahri locality. This fact may influence the external validity of the study. Another possible limitation to internal validity of the study would be the selection bias. Selection bias was imposed by the fact that doctors who did not hear about the DOACs refused to voluntarily contribute to the study and were potentially excluded. This would be

attributed to the fact that the DOACs are relatively new agents in Sudan, having gained approval recently. Nevertheless, this study of the knowledge of the NOACs is the first of its kind in Sudan and may pave the way for further extensive studies in this area. Furthermore, the study can open the door to introducing a validated tool for knowledge, attitudes, and practices of DOACs. Moreover, placing greater emphasis on the involvement of clinical pharmacists in Sudanese clinical settings could help enhance the utilization of DOACs and improve overall practices related to these new medications.

7. Declarations

7.1. Acknowledgements

The authors are thankful to all the doctors in the selected hospitals who participated and helped facilitate the smooth conduct of this study.

7.2. Ethical Considerations

This study adhered to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the Medical Ethical Committee, Ministry of Health, Khartoum State (Serial Number: KMOH-REC-2022-NO.13.2). All eligible doctors attending during the study period were selected and asked to participate in the study after obtaining written informed consent.

7.3. Competing Interests

No potential conflict of interest was reported by the authors.

7.4. Availability of Data and Material

All materials of this study are available from the corresponding author upon reasonable request.

7.5. Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

7.6. Abbreviations and Symbols

DOACs: Direct oral anticoagulants

FDA: Food and Drug Administration

ACS: Acute coronary syndrome

INR: International normalization ration

NVAF: Nonvalvular atrial fibrillation

VTE: Venous thromboembolism

CrCl: Creatinine clearance

AHA: American Heart Association

ICU: Intensive care units

CCU: Coronary care units

CHD: Coronary artery disease

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