Původní sdělení | Original research article

Study of the Effect of Telecommunication Follow-Up for Patients on Warfarin During the COVID-19 Pandemic

Mohamed A. Abdelwahab[a], Karim Kamal[b], Mohamed El-Ramly[a], Kareem Mahmoud[a]

[a] *Department of Cardiovascular Medicine, Kasr Alainy Hospital, Faculty of Medicine, Cairo University, Cairo, Egypt*
[b] *Sohag Heart and GIT Specialized Center, Sohag, Egypt*

ARTICLE INFO

Article history:
Submitted: 8. 8. 2025
Accepted: 1. 9. 2025
Available online: 11. 5. 2026

Klíčová slova:
INR
Telemedicína
TTR
Warfarin

SOUHRN

Kontext: Perorálně užívané antikoagulancium warfarin, antagonista vitaminu K, vyžaduje časté monitorování mezinárodního normalizovaného poměru (international normalized ratio, INR). Z telemedicíny se v poslední době stal významný nástroj léčby pacientů umožňující poskytování zdravotní péče na dálku, zvláště během pandemie infekčního onemocnění covid-19. Účinnost a bezpečnost tohoto způsobu péče o pacienty užívající warfarin v Egyptě dosud nebyly definovány.
Cíl: Tato studie srovnávala telemedicínu s klasickou ambulantní léčbou warfarinem z hlediska dosahování cílové INR a doby v terapeutickém rozmezí (time in therapeutic range, TTR) a současně hodnotila rozdíly mezi oběma metodami a komplikace.
Metody: Pacienti užívající warfarin na dvou egyptských pracovištích terciární péče byli randomizováni do dvou skupin, jedné léčené prostřednictvím telemedicíny a druhé s klasickou ambulantní léčbou. V telekomunikační medicíně se používaly telefon a aplikace WhatsApp. Sledovaly se hodnoty INR a TTR, analyzovaly náklady a komplikace.
Výsledky: Do této tříměsíční studie bylo zařazeno 200 pacientů. S výjimkou vyššího procenta kuřáků ve skupině s ambulantní léčbou při zařazení do studie nebyly nalezeny žádné statisticky významné rozdíly (40 % vs. 24 %; $p = 0,02$). Cílové hodnoty TTR (> 70 %) bylo dosaženo u 78 % ambulantních pacientů a 82 % pacientů léčených prostřednictvím telemedicíny ($p = 0,48$). U pacientů se vstupní hodnotou INR < 2 bylo procento dosažení cílové hodnoty TTR statisticky významně vyšší než ve skupině s telemedicínou (76,5 % vs. 30,8 %; $p < 0,001$). Incidence supraterapeutické hodnoty INR byla vyšší ve skupině ambulantních pacientů (40 % vs. 20 %; $p = 0,002$). Mezi skupinami nebyly zaznamenány žádné statisticky významné rozdíly v krvácivých nebo trombotických příhodách. Použití telemedicíny bylo spojeno se statisticky významně nižšími náklady než ambulantní léčba.
Závěr: Použití telekomunikační techniky představuje účinnou alternativu léčby warfarinem při srovnatelné účinnosti a bezpečnosti v městských i venkovských podmínkách. Tato metoda statisticky významně snižuje zátěž z hlediska nákladů na zdravotnická zařízení i na samotné pacienty. Doporučujeme přijetí standardizovaných telekomunikačních metod v širším měřítku v egyptské klinické praxi.

Keywords:
INR
Telemedicine
TTR
Warfarin

ABSTRACT

Background: Warfarin, a vitamin K antagonist oral anticoagulant, requires frequent monitoring of the international normalized ratio (INR). Telemedicine has emerged as a crucial tool for facilitating remote healthcare access, particularly during the COVID-19 pandemic. However, the efficacy and safety of this model for managing warfarin patients in Egypt remain unexplored.
Aim: This study compared telemedicine with conventional warfarin clinic visits regarding achieving target INR and time in therapeutic range (TTR), while assessing differences in expenses and complications.
Methods: Patients receiving warfarin at two tertiary centers in Egypt were randomized into telemedicine or conventional clinic groups. Telemedicine communication utilized telephone and WhatsApp. INR, TTR, cost analysis, and complications were evaluated.
Results: This three-month study included 200 patients. No significant baseline differences existed between groups except for higher smoking rates in the clinic group (40% vs. 24%, $p = 0.02$). Target TTR (>70%) was achieved in 78% of clinic patients and 82% of telemedicine patients ($p = 0.48$). Among patients with baseline INR <2, target TTR achievement was significantly higher in the telemedicine group (76.5% vs. 30.8%,

Address: Mohamed A. Abdelwahab, Department of Cardiovascular Medicine, Kasr Alainy Hospital, Al-Manial, Faculty of Medicine, Cairo University, 11562 Cairo, Egypt, e-mail: mohamed.a.adel@kasralainy.edu.eg
DOI: 10.33678/cor.2025.094

Please cite this article as: Abdelwahab MA, Kamal K, El-Ramly M, Mahmoud K. Study of the Effect of Telecommunication Follow-Up for Patients on Warfarin During the COVID-19 Pandemic. Cor Vasa 2026;68:143–149.

p <0.001). Supratherapeutic INR incidence was higher in the clinic group (40% vs. 20%, *p* = 0.002). No significant differences in bleeding or thrombotic events occurred between groups. Telemedicine services demonstrated significantly lower costs than conventional clinics.

Conclusion: Telecommunication offers a feasible alternative for warfarin management with comparable efficacy and safety in both urban and rural areas. This method significantly reduces cost burden on healthcare facilities and patients. We recommend adopting standardized telecommunication methods on a broader scale in Egyptian clinical practice.

Introduction

Warfarin, a vitamin K antagonist, has been used for decades to prevent arterial and venous thromboembolism in various cardiovascular conditions, including atrial fibrillation, venous thromboembolism, prosthetic heart valves, and left ventricular mural thrombus.[1] Physicians use the international normalized ratio (INR) to determine the warfarin dose, which is essential for confirming the efficacy and safety of anticoagulation.[2] Failure to achieve the target INR can expose patients to serious adverse events, such as systemic or venous thromboembolism with low INR values or bleeding complications with high INR values.

Telemedicine refers to the provision of remote clinical services via real-time two-way communication between the patient and the healthcare provider, using electronic audio and/or visual means.[3] Telemedicine can offer teleconsultations, reduce waiting times, provide access to high-quality medical diagnoses and treatments, enhance professional education, and lower the cost of medical consultations.[4] The main drawbacks of telemedicine include the lack of in-person physical examination, as well as organizational, bureaucratic, and technological difficulties.[5]

In the COVID-19 era, telemedicine offers numerous benefits, including reducing infection spread and pollution by enabling social distancing and avoiding unnecessary movement.[6] It also increases accessibility for patients in remote rural areas, particularly during lockdown periods.[7]

According to a recent systematic review,[8] only 35.1% of Egypt's population has utilized telehealth services, despite their potential benefits in the healthcare sector. This is comparable to findings from other developing nations.[9] As part of the Egyptian Government's Vision 2030, which includes digital transformation, the telemedicine sector in Egypt has significant growth potential, driven by technological advancements, increasing internet penetration, digital infrastructure investment, public education and awareness, and the issuance of supportive regulatory laws and clear policies.[10]

The role of telemedicine in improving the management of warfarin has been tested in comparison to conventional clinic visits in several previous studies.[11–13] The COVID-19 pandemic has promoted further widespread use of telemedicine, particularly during lockdown. However, the efficacy and safety of this model for managing warfarin patients in Egypt remain unexplored.

Our aim in this study was to compare telemedicine with conventional warfarin clinic visits in terms of achieving target INR and time in therapeutic range (TTR). We also compared the two groups regarding average expanses and the development of complications during the study period.

Patients and methods

This experimental study tested the feasibility of telecommunication follow-up of INR in a developing country. Patients on warfarin who presented to outpatient clinics at two tertiary centers in Egypt, representing both urban and rural areas, were screened for warfarin indication, current dose, and history of previous complications related to warfarin therapy. Patients were then randomized into two groups: the telemedicine group and the conventional warfarin clinics. Telephone and WhatsApp were used for telemedicine communication, as per the Telemedicine Practice Guidelines.[14] At the end of the study, a review of INR, TTR, and cost analysis of both methods, as well as the development of thrombotic or bleeding complications, was conducted. Informed written consent was obtained from all participants, and the local ethics committee approved the study.

Inclusion criteria:

- Patients aged over 18 years, on warfarin therapy, and capable of managing their medication.

Exclusion criteria:

- History of non-compliance with warfarin.
- Liver disease.
- Severe chronic kidney disease (GFR less than 30 ml/min/1,73 m^2).
- Patients on drugs that interact with warfarin (imatinib, Fluorouracil (5-FU), Amiodarone).
- Patients with acute illness.
- Patients scheduled for any surgery within three months.

Methods

All patients underwent:

1. History taking, including age, sex, residence, education level, height, weight, and BMI, indication for warfarin therapy, warfarin dose and duration of therapy, and history of comorbidities such as hypertension, diabetes, liver or kidney disease, and previous warfarin complications like bleeding or thromboembolic events.

2. Laboratory data:
   - International normalized ratio (INR): A venous blood sample was withdrawn when patients presented to

the approved laboratory. The prothrombin time was performed, and the result was expressed as INR.[15]
- Time in therapeutic range (TTR): TTR was calculated using the Rosendaal linear interpolation technique for each patient.[16] The Rosendaal method assumes that the INR changes the same amount each day. TTR results can be categorized into three groups: high (>70%), moderate (50% to 70%), and low (<50%). High TTR and stable anticoagulation in reference groups denote reasonable control.[17]
  - INR follow-up:
  - If the target INR was not achieved, INR was repeated after 5–7 days.
  - If the target INR was achieved, it was repeated every month until the end of the study.
  - Target INR was determined according to the clinical indication of anticoagulation, following the guidelines for atrial fibrillation, venous thromboembolism and valvular heart disease.[18–20]

3. Costs:
The patients in each arm were surveyed regarding the average expenses for visits.
Expenses included direct costs such as transportation, time off work, administrative costs, lab tests, and data usage (mainly for telecommunication).

4. Complications
a. Bleeding: According to the International Society on Thrombosis and Haemostasis (ISTH) Criteria,[21] bleeding was classified into:
Major bleeding if it meets ≥1 of the following:
- Fatal bleeding (directly causes death).
- Symptomatic bleeding in a critical organ (e.g., intracranial, intraocular, retroperitoneal, intra-articular, pericardial, intramuscular with compartment syndrome).
- Bleeding causing a ≥2 g/dL drop in hemoglobin or requiring ≥2 units of blood transfusion.
- Bleeding leading to hospitalization or prolonged hospitalization.

Minor bleeding:
- Any clinically relevant bleeding that does not meet major criteria but requires:
  - Medical intervention (e.g., topical treatment, compression).
  - Unscheduled contact with a healthcare provider.
  - Temporary discontinuation of study drug.
  - Examples: Epistaxis (nosebleed), gum bleeding, mild bruising, or hematuria not requiring transfusion.

b. Thromboembolism:
- Embolic stroke: A neurologic deficit of sudden onset confirmed by CT/MRI.
- Arterial thromboembolism leading to limb ischemia, mesenteric ischemia, renal or splenic infarcts, documented clinically and by CT/MRI angiographic imaging.
- Venous thromboembolism in the form of deep venous thrombosis (leg swelling or pain associated with visible thrombi on compression ultrasound) or pulmonary embolism (acute dyspnea or chest pain associated with pulmonary artery thrombi on CT pulmonary angiography).
- Mechanical valve thrombosis: valve impairment by thrombus deposition on the valve associated with subtherapeutic INR, confirmed by transesophageal echocardiography or fluoroscopy.
- Supratherapeutic INR without bleeding refers to an INR value higher than the target therapeutic range but without bleeding.

Statistical analysis

Data were analyzed using STATA version 14.2 (Stata Statistical Software: Release 14.2 College Station, TX: StataCorp LP). Quantitative data were represented by mean, standard deviation, median, and range. Data were analyzed using a Student's t-test to compare the means of the two groups. When data were not normally distributed, the Mann–Whitney test was used to compare the two groups. Qualitative data were presented as numbers and percentages and compared using either the Chi-square test or Fisher's exact test. Graphs were produced using Excel or the STATA program. The *p*-value was considered significant if it was less than 0.05.

Results

This study included 200 warfarin-prescribed patients with a three-month follow-up. **Table 1** compares the baseline characteristics of patients allocated to conventional warfarin clinics or the telemedicine method. No significant difference was observed between the two groups, except for a significantly higher number of smokers in the warfarin clinic group (40% vs. 24%, $p = 0.02$). There was no significant difference between the two groups regarding the indication for anticoagulation.

Table 1 – Comparison of baseline characteristics between patients treated with telemedicine and those treated in the warfarin clinic

	Warfarin clinic N = 100	Telemedicine N = 100	*p* value
Age (years)	39.3 ± 11.1	38.1 ± 10.4	0.55
Female gender	52 (52.0%)	46 (46.0%)	0.40
Smoker	40 (40.0%)	24 (24.0%)	0.02
BMI	24.87 ± 2.58	24.02 ± 2.38	0.02
DM	14 (14.0%)	12 (12.0%)	0.67
HTN	16 (16.0%)	8 (8.0%)	0.08
Indication of warfarin			
MVR	46 (46.0%)	50 (50.0%)	0.57
AVR	18 (18.0%)	22 (22.0%)	0.48
DVR	20 (20.0%)	18 (18.0%)	0.72
AF	18 (18.0%)	12 (12.0%)	0.234
LV thrombus	2 (2.0%)	2 (2.0%)	1.00
DVT	4 (4.0%)	2 (2.0%)	0.407

AF – atrial fibrillation; AVR – aortic valve replacement; BMI – body mass index; DM – diabetes mellitus; DVR – double valve replacement; DVT – deep venous thrombosis; HTN – hypertension; LV – left ventricular; MVR – mitral valve replacement.

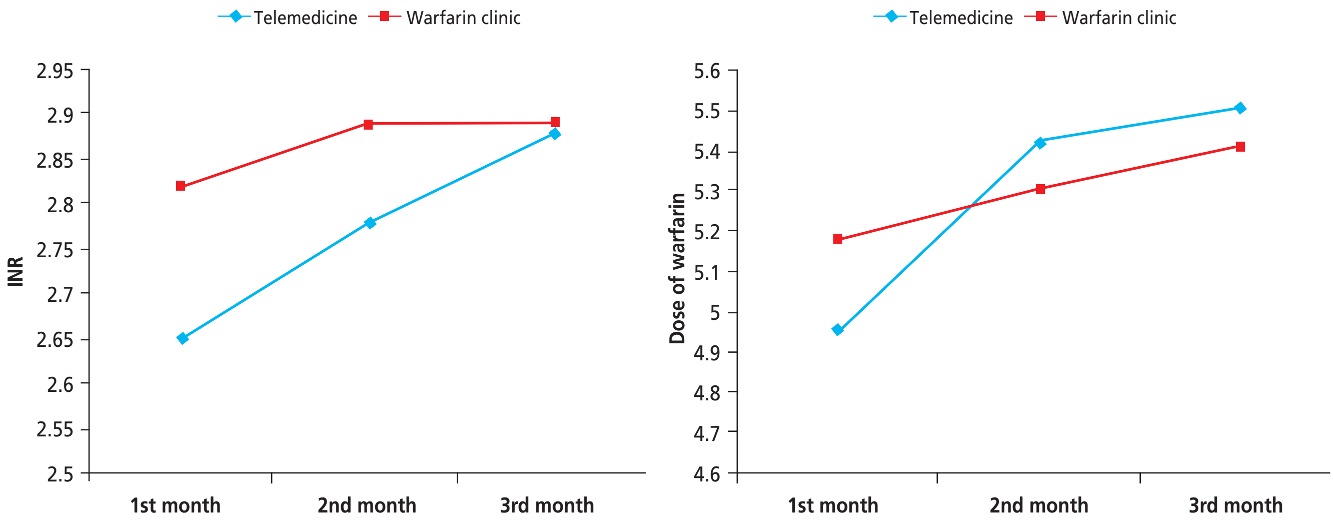
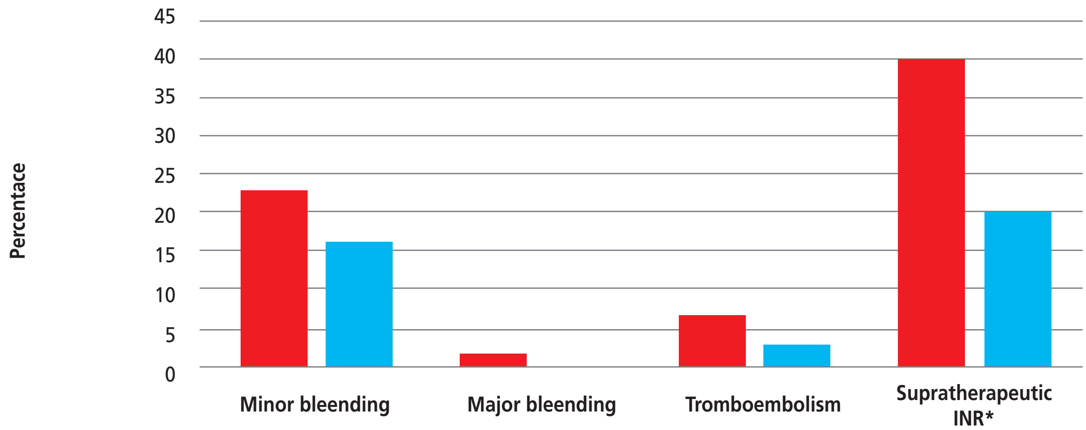


Fig. 1A – Follow-up INR over three months in both groups. (B) Average warfarin dose over the three-month follow-up.



	Minor bleending	Major bleending	Tromboembolism	Supratherapeutic INR*
Warfarin clinics	23	2	7	40
Telemedicine	16	0	3	20

Fig. 2 – Comparison of both groups regarding the outcomes.

No significant difference was observed regarding baseline or follow-up INR (**Fig. 1A**). The average warfarin dose required to achieve the target INR was comparable between the two groups (**Fig. 1B**). A target TTR (>70%) was achieved in 78% of patients in the warfarin clinic group and 82% in the telemedicine group (p = 0.48). However, achieving the target TTR was significantly higher in the telemedicine group among patients with a baseline INR of less than 2 (30.8% vs. 76.5%, p <0.001). The incidence of supratherapeutic INR was higher in the warfarin clinic group (40% vs. 20%, p = 0.002). Both groups showed no significant difference in bleeding or thrombotic events (**Fig. 2**). The estimated costs of telemedicine services were significantly lower than those of conventional warfarin clinics. **Table 2** compares the two groups regarding INR and TTR values, as well as the incidence of complications.

A comparison of the two groups in both urban and rural clinics yielded similar results. The achievement of target TTR in patients with baseline INR <2 was significantly higher among patients treated with telemedicine than those treated in the warfarin clinic in the urban regions (88.9% vs. 28.6%, p <0.001). In the rural regions, the achievement of target TTR was numerically higher in the telemedicine group (62.5% vs. 33.3%, p = 0.13). There is no significant difference between the two groups in terms of bleeding and thromboembolic complications in both regions. Again, the incidence of supratherapeutic INR was significantly lower in the telemedicine group in both regions. The estimated costs of

Table 2 – Comparison of patients treated with telemedicine with those treated in the warfarin clinic regarding the outcomes

	Warfarin clinic N = 100	Telemedicine N = 100	*p* value
Baseline INR	2.0 ± 0.4	2.1 ± 0.3	0.22
Baseline INR 1–2 >2	 26 (26.0%) 74 (74.0%)	 34 (34.0%) 66 (66.0%)	0.22
Follow up INR	2.8 ± 0.6	2.9 ± 0.7	0.35
Target INR 2.0–3.0 3.0–4.0	 80 (80.0%) 20 (20.0%)	 74 (74.0%) 26 (26.0%)	0.31
Target TTR >70%	78 (78.0%)	82 (82.0%)	0.48
Target TTR with baseline INR 1–2	8/26 (30.8%)	26/34 (76.5%)	<0.0001
Target TTR with baseline INR >2	70/74 (94.6%)	56/66 (84.8%)	0.055
The average dose of warfarin	5.3 ± 2.1	5.3 ± 1.7	0.98
Bleeding • Minor • Major	 23 (23.0%) 2 (2.0%)	 16 (16.0%) 0	0.15
Thromboembolism	7 (7.0%)	3 (3.0%)	0.19
Supratherapeutic INR	40 (40.0%)	20 (25.0%)	0.002
Cost (Egyptian pound)	205.7 ± 88.1	145.7 ± 58.3	<0.0001

Table 3 – Comparison of urban patients treated with telemedicine with those treated in the warfarin clinic regarding the outcomes

	Warfarin clinic N = 50	Telemedicine N = 50	*p* value
Baseline INR	2.0 ± 0.3	2.0 ± 0.4	0.41
Baseline INR 1–2 >2	 14 (28.0%) 36 (72.0%)	 18 (36.0%) 32 (64.0%)	0.39
Follow up INR	2.8 ± 0.6	2.8 ± 0.7	0.88
Target INR 2.0-3.0 3.0-4.0	 42 (84.0%) 8 (16.0%)	 36 (72.0%) 14 (28.0%)	0.15
Target TTR >70%	40 (80.0%)	42 (82.0%)	0.48
Target TTR with baseline INR 1–2	4/14 (28.6%)	16/18 (88.9%)	<0.0001
Target TTR with baseline INR >2	36/36 (100%)	26/32 (81.2%)	0.007
The average dose of warfarin	5.3 ± 2.1	5.3 ± 1.7	0.98
Bleeding • Minor • Major	 10 (20.0%) 1 (2.0%)	 16 (16.0%) 0	0.42
Thromboembolism	1 (2.0%)	3 (3.0%)	0.31
Supratherapeutic INR	20 (40.0%)	8 (16.0%)	0.008
Cost (Egyptian pound)	254.8 ± 93.6	178.0 ± 65.6	<0.0001

Table 4 – Comparison of rural patients treated with telemedicine with those treated in the warfarin clinic regarding the outcomes

	Warfarin clinic N = 50	Telemedicine N = 50	*p* value
Baseline INR	2.1 ± 0.3	2.0 ± 0.4	0.36
Baseline INR 1–2 >2	 12 (24.0%) 38 (76.0%)	 16 (32.0%) 34 (68.0%)	 0.37
Follow-up INR	2.8 ± 0.6	3.0 ± 0.7	0.25
Target INR 2.0–3.0 3.0–4.0	 38 (76.0%) 12 (24.0%)	 38 (76.0%) 12 (24.0%)	1.0
Target TTR >70%	38 (76.0%)	40 (80.0%)	0.63
Target TTR with baseline INR 1–2	4/12 (33.3%)	10/16 (62.5%)	0.13
Target TTR with baseline INR >2	34/38 (89.5%)	30/34 (88.2%)	0.87
The average dose of warfarin	6.1 ± 2.4	5.1 ± 1.5	0.08
Bleeding • Minor • Major	 13 (26.0%) 1 (2.0%)	 9 (18.0%) 0	0.36
Thromboembolism	2 (4.0%)	4 (8.0%)	0.40
Supratherapeutic INR	20 (40.0%)	8 (16.0%)	0.09
Cost (Egyptian pound)	156.6 ± 44.8	113.4 ± 20.7	<0.0001

telemedicine service were also significantly lower than those of conventional warfarin clinics in both regions. **Tables 3** and **4** show the comparison between groups in the urban and rural regions.

Discussion

This study compared the effectiveness of telemedicine with conventional clinic visits for warfarin therapy management, demonstrating comparable efficacy in achieving target time in therapeutic range (TTR) and similar rates of bleeding or thromboembolic events.

Our prospective study, conducted in two tertiary medical centers in Egypt (urban and rural), evaluated telemedicine-based strategies against conventional oral anticoagulation clinic visits for various warfarin indications. The primary indication for warfarin in our cohort was mechanical prosthetic valves, followed by atrial fibrillation. This aligns with current medical practice where non-vitamin K oral anticoagulants (NOACs) have largely replaced vitamin K antagonists (VKAs) for non-valvular atrial fibrillation[18] and venous thromboembolism,[19] while VKAs remain crucial for conditions like mechanical heart valves and rheumatic mitral stenosis,[20] and antiphospholipid syndrome.[22]

Optimal TTR is generally recommended to be above 70% by European consensus[23] and above 65% for AF patients on VKA therapy by NICE guidelines,[24] though meta-analyses often report TTRs at or below 60%.[25,26]

Most patients (80%) in our study achieved a target TTR >70%, with no significant difference between telemedicine and conventional clinic visits (82% vs. 78%, p = 0.48). This comparable, or even superior, effectiveness of telemedicine has been observed in other studies during the COVID-19 lockdown.[27–29] For instance, a Chinese retrospective study found a smartphone application (Alfalfa) improved TTR significantly compared to offline management (61.0% vs. 39.6%).[27] Similarly, an Indian study using WhatsApp and telephone tools reported better TTR in a Virtual Anticoagulation Clinic (VAC) group than in a Standard Anticoagulation Clinic (ACC) group (75.4% vs. 71.2%, p <0.001), with no major adverse events.[28] Our high proportion of effectively controlled patients is likely due to the prospective nature of the study and the recruitment of younger patients with fewer comorbidities and polypharmacy.

Notably, one third of our patients was uncontrolled at enrollment (baseline INR 1–2). In this subgroup, telemedicine was significantly more effective in achieving a target TTR >70% (76.5% vs. 30.8%, p <0.001). This aligns with findings by Emily et al.[30] who observed an increase in INR values within the target range (from 62.5% to 72.7%, p = 0.07) and a decrease in extreme INR values (from 4.8% to 0.01%, p = 0.01) with telemedicine. Conversely, Al Ammari et al.[31] found telemedicine less effective for newly prescribed warfarin patients, suggesting that telemedicine and conventional visits may be synergistic and complementary, with a patient needs dictating the appropriate approach.

Major adverse events were numerically small in our study, with no statistically significant difference in bleeding or thromboembolic events between groups. However, supratherapeutic INR readings without bleeding were significantly lower in the telemedicine group compared to conventional clinics, regardless of the target INR range (e.g., 18.4% vs. 33.8% for INR 2–3.5, p = 0.030). This safety profile of telemedicine-based VKA management, showing no significant difference in major bleeding or thromboembolic events compared to conventional care, is consistent with previous research.[27,28,32] A meta-analysis of 25 randomized controlled trials (n = 25,746 patients) further supported this, showing a trend towards lower thromboembolic events (RR 0.75), comparable major bleeding (RR 0.94), and mortality (RR 0.96), and improved TTR (mean difference 3.38) with telemedicine.[33]

Our study is the first Egyptian analysis to demonstrate that telemedicine-based management significantly reduced costs compared to conventional clinic-based management, irrespective of TTR achievement (e.g., 128.05 ± 22.63 vs. 173.46 ± 37.73, p <0.0001). While Al Ammari et al.[31] noted less substantial cost reduction in Saudi Arabia, they highlighted increased resource utilization (clinical pharmacists). The ThrombEVAL study[34] also found that increased direct costs were offset by fewer adverse events and hospitalizations, leading to overall healthcare expenditure reduction. Future research should conduct in-depth cost-effectiveness analyses of various telemedicine strategies to support implementation and inform reimbursement policies, especially as cost and reimbursement remain barriers.

Crucially, the comparable efficacy, safety, and superior cost-reduction of telemedicine-based oral anticoagulant (OAC) management were reproducible across both study centers, underscoring the potential for broader telemedicine adoption in Egypt.

Limitations of our study include a relatively small patient number, possibly due to the decreased use of warfarin in favor of NOACs. A larger study with diverse age groups and comorbidities would enhance generalizability. The short follow-up duration might underestimate adverse effects. Additionally, the lack of standardized medical telemedicine tools locally presents a challenge.

Conclusion

This study demonstrates that a telecommunication clinic offers a feasible alternative for uninterrupted anticoagulation care for warfarin patients. Telemedicine provides acceptable INR and TTR control without increasing complications, while significantly reducing the cost burden on healthcare facilities and patients. We recommend adopting standardized telecommunication methods more broadly in clinical practice to facilitate close patient monitoring and prompt medication adjustments.

Conflict of interest
The authors declare that they have no competing interests.

Funding
No funding.

Ethical statement
The present study was conducted in accordance with the declaration of Helsinki. Ethical approval was formally granted by the Cairo University Ethics Committee (ref. n. MS-147-2021).

Informed consent
Prior to inclusion, written informed consent was obtained from all individual participants.

References

1. Ageno W, Gallus AS, Wittkowsky A, et al. Oral anticoagulant therapy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012;141(2 Suppl):e44S–e88S.
2. Ansell J, Hirsh J, Hylek J, et al. Pharmacology and management of the vitamin K antagonists: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest 2008;133(6 Suppl):160S–198S.
3. World Health Organization. Telemedicine: opportunities and developments in member states: report on the second global survey on eHealth. Geneva: World Health Organization; 2010. Online. Available from: https://apps.who.int/iris/handle/10665/44497. [cited 2026-05-10].
4. Al-Samarraie H, Al-Rahmi WM, Al-Sharafi A, et al. The impact of telemedicine on healthcare quality and patient satisfaction: a systematic review. J Telemed Telecare 2023;29:3–17.
5. Bashshur RL, Shannon GW, Smith BR, et al. Telemedicine and health care reform. Telemed J E Health 2011;17:483–490.

6. Monaghesh E, Ramezani A. The role of telemedicine during COVID-19 pandemic: a systematic review. Telemed J E Health 2020;26:599–606.
7. Chu C, Cram P, Pang A, et al. Rural Telemedicine Use Before and During the COVID-19 Pandemic: Repeated Cross-sectional Study. J Med Internet Res 2021;23:e26960.
8. Akuana CM, Mohammadnezhad M. Utilization and impact of telemedicine among individuals in Egypt: a systematic review. MOJ Public Health 2025;14:59-65.
9. Combi C, Pozzani G, Pozzi G. Telemedicine for Developing Countries. A Survey and Some Design Issues. Appl Clin Inform 2016;7:1025–1050.
10. Ministry of Communications and Information Technology, Egypt. Digital Egypt Strategy 2030. Online. Available from: https://www.mcit.gov.eg/en/Digital_Egypt_Strategy_2030. [cited 2026-05-10].
11. Sakunrag I, Danwilai K, Dilokthornsakul P, et al. Clinical outcomes of telephone service for patients on warfarin: a systematic review and meta-analysis. Telemed J E Health 2020;26:1507–1521.
12. Bernstein MR, John L, Sciortino S, et al. Does telehealth improve anticoagulation management in patient service centers (PSC)? A pilot project. J Thromb Thrombolysis 2020;49:316–320.
13. Prochaska JH, Gobel S, Keller K, et al. Quality of oral anticoagulation with phenprocoumon in regular medical care and its potential for improvement in a telemedicine-based coagulation service – results from the prospective, multi-center, observational cohort study thrombEVAL. BMC Med 2015;13:14.
14. Mars M. Medicolegal, ethical, and regulatory guidelines pertaining to telehealth. In: Fundamentals of Telemedicine and Telehealth. 2020:297–303.
15. Dorgalaleh A, Favaloro EJ, Bahraini M, Rad F. Standardization of Prothrombin Time/International Normalized Ratio (PT/INR). Int J Lab Hematol 2021;43:21–28.
16. Rosendaal FR, Cannegieter ER, van der Meer FJ, Briët E. A method to determine the optimal intensity of oral anticoagulant therapy. Thromb Haemost 1993;70:103–107.
17. Hylek EM, Skates SJ, Sheehan PA, Singer DE. An analysis of the quality of anticoagulation in a community-based cohort of patients with atrial fibrillation. Stroke 2003;34:2653–2658.
18. Van Gelder IC, Rienstra M, V Bunting K, et al. 2024 ESC Guidelines for the management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS): Developed by the task force for the management of atrial fibrillation of the European Society of Cardiology (ESC), with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC. Endorsed by the European Stroke Organisation (ESO). Eur Heart J 2024;45:3314–3414.
19. Konstantinides SV, Meyer G, Becattini C, et al. 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS): The Task Force for the diagnosis and management of acute pulmonary embolism of the European Society of Cardiology (ESC). Eur Heart J 2020;21:543–603.
20. Vahanian A, Beyersdorf F, Praz F, et al. 2021 ESC/EACTS Guidelines for the management of valvular heart disease: Developed by the Task Force for the management of valvular heart disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J 2022;43:561–632.
21. Schulman S, Kearon C. Subcommittee on Control of Anticoagulation of the SSC of the ISTH. Definition of major bleeding in clinical trials of antithrombotic agents in surgical patients. J Thromb Haemost 2005;3:692–694.
22. Tektonidou MG, Andreoli L, Limper M, et al. EULAR recommendations for the management of antiphospholipid syndrome in adults. Ann Rheum Dis 2019;78:1296–1304.
23. Camm AJ, Lip GY, De Caterina R, et al. 2012 focused update of the ESC Guidelines for the management of atrial fibrillation: an update of the 2010 ESC Guidelines for the management of atrial fibrillation. Developed with the special contribution of the European Heart Rhythm Association. Eur Heart J 2012;33:2719–2747.
24. National Clinical Guideline Centre (UK). Atrial Fibrillation: The Management of Atrial Fibrillation. London: National Institute for Health and Care Excellence (UK) (2014).
25. Mearns ES, White CM, Kohn CG, et al. Quality of vitamin K antagonist control and outcomes in atrial fibrillation patients: a meta-analysis and meta-regression. Thrombosis J 2014;12:1–20.
26. Haas S, Ten Cate H, Accetta G, et al. Quality of vitamin K antagonist control and 1-year outcomes in patients with atrial fibrillation: a global perspective from the GARFIELD-AF registry. PLoS One 2016;11:e0164076.
27. Jiang S, Lv M, Zeng Z, et al. Efficacy and safety of app based remote warfarin management during COVID 19 related lockdown: a retrospective cohort study. J Thromb Thrombolysis 2022;54:20–28.
28. Shambu SK, Shetty SP, Gona OJ, et al. Implementation and Evaluation of Virtual Anticoagulation Clinic Care to Provide Incessant Care During COVID-19 Times in an Indian Tertiary Care Teaching Hospital. Front Cardiovasc Med 2021;8:648265.
29. Alanazi Z, Almutairi N, AlDukkan L, et al. Time in therapeutic range for virtual anticoagulation clinic versus in-person clinic during the COVID-19 pandemic: a crossover study. Ann Saudi Med 2022;42:305–308.
30. Hawes EM, Lambert E, Reid A, et al. Implementation and evaluation of a pharmacist-led electronic visit program for diabetes and anticoagulation care in a patient-centered medical home Am J Health Syst Pharm 2018;75:901–910.
31. Al Ammari M, AlThiab K, AlJohani M, et al. Tele-pharmacy anticoagulation clinic during COVID-19 pandemic: patient outcomes. Front Pharmacol 2022;12:652482.
32. Singh G, Kapoor S, Bansal V, et al. Active surveillance with telemedicine in patients on anticoagulants during the national lockdown (COVID- 19 phase) and comparison with pre-COVID-19 phase. Egypt Heart J 2020;72:70.
33. Braga Ferreira L, Lanna de Almeida R, Arantes A, et al. Telemedicine-Based Management of Oral Anticoagulation Therapy: Systematic Review and Meta-analysis. J Med Internet Res 2023;25:e45922.
34. Eggebrecht L, Ludolph P, Göbel S, et al. Cost saving analysis of specialized, eHealth-based management of patients receiving oral anticoagulation therapy: results from the thrombEVAL study. Sci Rep 2021;11:2577.