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Exploring Italian nursing staff in anticoagulation clinics: a cluster-based description of current practice, nurse self-efficacy, job satisfaction, and interprofessional collaboration

Arianna Magon[1] · Rosario Caruso[2,3] · Cristina Arrigoni[4] · Marcello Torre[5] · Antonio M. G. Staffa[5] · Marco Paolo Donadini[6] · Walter Ageno[7] · Alessandro Squizzato[8] · Paolo Bucciarelli[9] · Antonio Ciampa[10] · Daniela Poli[11]

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Abstract

This study aimed to describe the competence profiles, practices, job satisfaction, and interprofessional collaboration among nurses working in Italian anticoagulation clinics (ACs) affiliated with the Italian federation of centres for the surveillance of anticoagulant therapy (FCSA). Data were collected via a web survey from December 2023 to May 2024. The information was condensed into two stochastic components using the *t*-distributed stochastic neighbour embedding (t-SNE) algorithm as part of the hierarchical clustering procedure, revealing two distinct clusters labelled "substandard profile" ($n=21$ nurses) and "proficient profile" ($n=38$ nurses). Results indicated significant variability in nursing practices, with differences in educational activities, self-reported competence, and levels of interprofessional collaboration between the two clusters. The findings underscore the importance of tailored interventions to enhance nursing practices, nursing education, and interprofessional collaboration within ACs. Future corroboration of the emerging results is warranted with longitudinal studies.

Keywords Nursing competence · Anticoagulation clinics · Interprofessional collaboration · T-SNE · Job satisfaction · Cluster analysis

Introduction

Anticoagulation clinics (ACs) are specialized services aimed at improving the management and surveillance of oral anticoagulation treatment (OAC) and providing diagnosis, treatment, and prevention of thromboembolic disorders [1, 2]. Consequently, the organizational model of ACs has become widespread, emerging as the best management model for OAC in patients treated with vitamin K antagonists (VKAs), improving anticoagulation control quality while maintaining low bleeding and thrombotic complication rates [3, 4]. Nonetheless, with the introduction of direct

✉ Rosario Caruso
rosario.caruso@unimi.it

1 Department of Public Health, Experimental and Forensic Medicine, University of Pavia, Pavia, Italy

2 Department of Biomedical Sciences for Health, University of Milan, Milan, Italy

3 Health Professions Research and Evidence Transfer Unit, IRCCS MultiMedica, Sesto San Giovanni, Italy

4 Section of Hygiene, Department of Public Health, Experimental and Forensic Medicine, University of Pavia, Pavia, Italy

5 Healthcare and Social Professions Management, ASST Sette Laghi, Varese, Italy

6 Department of Medicine and Surgery, Research Center on Thrombosis and Antithrombotic Therapies, University of Insubria, Varese, Italy

7 Department of Medicine and Surgery, University of Insubria, Varese, Italy

8 ASST Lariana, Research Center on Thromboembolic Disorders and Antithrombotic Therapies, University of Insubria, Como, Italy

9 Fondazione IRCCS Ca' Granda-Ospedale Maggiore Policlinico, A. Bianchi Bonomi Hemophilia and Thrombosis Center, Milan, Italy

10 Haemostasis Center, 'Moscati' Hospital, Avellino, Italy

11 Thrombosis Center, 'Careggi' Hospital, Florence, Italy

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oral anticoagulants (DOACs), the growing prevalence of patients needing OAC treatment and more complex healthcare needs, the organizational model of ACs has evolved from a predominantly physician-centred approach to an integrated care approach [5]. This evolution has led to greater recognition and involvement of various healthcare professionals in ACs, such as nurses, pharmacists, and biologists, as well as to the recognition of patients as active partners in their treatment, thereby providing more comprehensive care in managing OAC [6–8]. Accordingly, given the advantages of ACs, the recent ESC guidelines recommend an integrated care approach, an organizational model for providing coordinated, evidence-based care by an interdisciplinary team [9].

In Italy, ACs are recognized as a model of care for the management of OAC [1, 2]. The network of ACs is well represented at the national level and coordinated by the Italian Federation of Centres for the Surveillance of Anticoagulant Therapy (FCSA). Currently, FCSA includes 220 affiliated ACs and follows up to 300,000 patients on VKAs [10]. Recently, FCSA conducted a survey to explore the attitudes and practices of FCSA-affiliated healthcare professionals regarding participation in clinical research. This survey presents results for physicians (82% of respondents) and biologists (18% of respondents) working in affiliated ACs, representing the first national attempt to inquire into the structure and function of anticoagulation clinic staff [10]. However, more research is needed to explore the contribution of each professional group working in ACs to ensure high-quality care in managing OAC. In this regard, nurses and pharmacists are generally the most commonly represented healthcare professionals in ACs [6, 7, 11]. Studies conducted by Barnes et al. showed that ACs were most heavily staffed with nurses and that practice variation in ACs is related to the scope of practice of each professional within the anticoagulation clinic staff [6]. For example, face-to-face consultations and phone-based care monitoring activities were most common in ACs with more nursing staff compared to those with more pharmacist staff [6]. In other words, adequate staffing, qualified professionals, and a favourable organizational climate characterize high-performing ACs [6, 12].

Nurses play a pivotal role in all areas of anticoagulation care management. The nursing scope of practice in OAC management primarily involves identifying cardiovascular and drug-related risk factors, providing direct clinical care and health education, offering follow-up care, and promoting medication adherence and self-care behaviours in patients managing anticoagulant therapy [13–15]. Consequently, several studies have focused on implementing nurse-led interventions to provide patient-centred care and promote adherence to evidence-based guidelines in routine anticoagulation care [16, 17]. Considering the opportunity for nurse involvement in OAC management, the study by Oterhals et al. highlighted critical knowledge and practice levels among European cardiovascular nurses in managing OAC [18]. Other international studies support this evidence [19–21].

Recently, the study by Magon et al. reported low self-efficacy among Italian nurses in OAC management [13]. In this scenario, a detailed description of nursing competence and practice in OAC management, as well as a description of the nursing staff in Italian ACs, is lacking. This gap limits the ability to identify distinct professional profiles, understand variability in clinical practice, and inform targeted educational and organizational interventions to optimize OAC management. For these reasons, this study aims to a) describe the nursing staff working in Italian ACs affiliated with FCSA about specific clusters that explain the patterns of responders, b) describe nursing competence and practices in OAC management, and c) describe nursing levels of job satisfaction and interprofessional collaboration. The significance of adopting a cluster-based approach in this study lies in its ability to enrich the descriptive aims by uncovering distinct patterns and profiles among the nursing staff working in Italian ACs. This approach provides a more nuanced and detailed picture of the current state of nursing in ACs and highlights areas for targeted interventions and improvements.

Methods

Study design, eligibility criteria, and procedure

This study has a descriptive, cross-sectional design. Data were collected through a web survey from December 2023 to May 2024. The target population consisted of nurses working in Italian ACs affiliated with FCSA who voluntarily participated in the survey. To be eligible, participants had to be currently employed as nurses in these ACs. There were no specific restrictions regarding the length of employment or the level of experience. To reach nurses working in ACs affiliated with FCSA, we used two main strategies to disseminate the survey. First, we contacted all ACs' references and asked them to disseminate the web survey link to the nursing staff under their responsibility. ACs' references were local managers appointed by FCSA and were accountable for promoting the implementation of evidence-based practices in OAC management. In addition, we directly contacted a few nurses working in Italian ACs and invited them to participate in the survey. These participants were then encouraged to refer or invite other eligible nurses from their professional networks to complete the survey as well. This method helped us reach a broader, more representative sample of nurses working in Italian ACs, despite not offering any incentives for participation.

The web survey was created using the SurveyMonkey® platform [22]. Without a contact list of nurses working in Italian ACs, a web link was sent via email to all references of the affiliated ACs ($n = 220$), with two reminders sent between January and March 2024. Furthermore, the web link was shared through the FCSA mobile app (FCSApp) to promote participation among affiliated members. The FCSA scientific committee preliminarily tested the web survey to assess the functionality and usability of the web link, and two nurses working in ACs to evaluate the comprehensibility and clarity of the items. More specifically, most of the items in the web survey were mandatory. Once a web page was submitted, a completion notification appeared automatically at the end of the web survey. Data from respondents who did not complete the survey were treated as missing. Finally, a collection restriction was applied by selecting the IP address to avoid duplicate responses [22]. All data collected via the SurveyMonkey® platform were encrypted during transmission using Secure Socket Layer (SSL) technology. This encryption ensured that the data could not be intercepted or accessed by unauthorized parties while being transmitted over the Internet. The Checklist for Reporting Results of Internet *E*-Surveys (CHERRIES) was used to ensure a complete description of the web survey design (Supplementary File 1) [23].

Measurements and item generation

The web survey was structured into two sections. The first section included the survey's welcome page, which contained a statement of the study's aim and privacy information. Only respondents who provided their electronically signed informed consent to proceed were able to complete the second part of the web survey. The second section collected data regarding the socio-demographic and professional profiles of nurses. A matrix of items was designed to assess the nurses' competence and practices in managing OAC. Additionally, the anticoagulation clinic referents collected information on the clinical and organizational characteristics of ACs (e.g. types of patients managed, number of staff members). Overall, the web survey comprised 50 items across 28 pages, with an average completion time of approximately 20 min.

Regarding the organizational aspects of ACs, as reported by the ACs references, four questions addressed the number and type of healthcare professionals comprising the ACs' staff, as well as the number of patients treated at each centre. Furthermore, to obtain a proxy measure of nursing turnover, we asked whether nurses working at ACs practised under stable conditions (i.e. low turnover) or, conversely, on an occasional basis (i.e. high turnover).

The scope of nursing practice in anticoagulation care was defined by referring to three previous European surveys conducted among cardiovascular nurses to assess educational and practice gaps in OAC management [13, 18, 21]. Additionally, specific contextual studies were considered, including the validation of a patient anticoagulation knowledge tool [24] and research on nursing barriers in managing OAC [25]. These studies helped adapt the e-survey items to the characteristics of the Italian healthcare system. Nursing practice patterns were assessed by asking nurses to rate the frequency with which they performed specific tasks during routine care in the ACs, using a Likert scale from 1 (never done) to 5 (always done). Additionally, nurses' practices regarding educational topics were investigated by type of oral anticoagulant (i.e., VKAs and DOACs).

Furthermore, nursing self-efficacy was assessed using the nursing self-efficacy for oral anticoagulant therapy management tool (SE-OAM). Several studies have recognized nursing self-efficacy as a reliable proxy for assessing nursing competence in specific tasks and situations [24]. The SE-OAM (21 items) is a valid and reliable self-report tool designed to evaluate self-efficacy in five main dimensions of nursing practice in OAC management: clinical management, care management, education, clinical monitoring, and care monitoring [13].

The organizational context of the ACs was assessed using the assessment of interprofessional team collaboration scale II (I-AITCS II) [25]. The I-AITCS II (23 items) is a valid self-report tool that measures interprofessional team collaboration across three dimensions: partnership, cooperation, and coordination. Instead, nursing job satisfaction was assessed with a single-item question on a Likert scale from 1 (low job satisfaction) to 7 (high job satisfaction) [26]. Furthermore, a single open-ended voluntary question was asked to explore nurses' perceptions of potential barriers to acknowledging and enhancing their role within the AC staff for OAC management.

Sample size

Given the limited existing research on the specific roles and characteristics of nursing staff in ACs, particularly in Italy, there was insufficient data available to accurately determine an appropriate sample size for our study using a precision-based approach. The composition of nursing staff and the norms for their practice were anticipated to vary significantly between countries, making it challenging to apply data from other contexts to the Italian setting. Because of the uncertainty in determining a precise sample size, we chose to use snowball sampling for data collection. Thus, to define an appropriate sample size, we employed a strategy rooted in the statistical principles of cluster analysis [27]. Based on empirical studies and Monte Carlo simulations, previous research suggests that a sample size of 20–30 participants per cluster is necessary for effective cluster separation and

reliable identification of subgroups [27]. This sample size provides sufficient statistical power to detect meaningful differences between clusters, particularly when subgroup separation is not large.

Statistical analysis

Descriptive statistics were used to analyse and report sample characteristics. Specifically, frequencies and percentages (%) were used for nominal and categorical study variables. Mean (*M*) and standard deviation (± SD) or median (Me) and interquartile range (IQR) were used for quantitative variables based on their distribution. Furthermore, inferential statistics were used to compare groups and assess relationships between variables. Missing data in our study were handled using multiple imputation under the assumption of missing at random [28]. We employed the "mice" package in *R* to perform multiple imputations using predictive mean matching, which is well suited for continuous and categorical data. The imputation process was iterated 50 times, yielding a single imputed dataset. The final analysis was conducted on the completed dataset derived from this imputation. Overall, missingness was always lower than 5%.

Quantitative information in the dataset ($n = 17$ variables), including socio-demographic data (age, general years of work experience, years of work in anticoagulation clinics, job satisfaction) and computed scores for various dimensions (total self-efficacy in oral anticoagulant therapy management, interprofessional collaboration measures: partnership, cooperation, coordination), as well as frequencies of specific nursing activities (education, monitoring, caring, clinical management, education for healthcare professionals, research, documentation, cooperation within the team, and cooperation with patients), was reduced into two components ($X1$ and $X2$) using the t-distributed stochastic neighbour embedding (t-SNE) algorithm. The t-SNE algorithm identifies similarities among data points in high-dimensional space. It converts these similarities into conditional probabilities that represent the likelihood that one point is a neighbour of another. This algorithm preserves both the linear and nonlinear relationships of the original variables. After exploring various perplexity values using scatterplots over the range 5–40, perplexity 15 was considered the most suitable. This value provided a balance between local and global aspects of the data, ensuring clear and distinct clustering in the t-SNE output, which was crucial for the practical identification of meaningful patterns in the dataset.

The two t-SNE components ($X1$ and $X2$) were used to perform hierarchical cluster analysis (HCA) using Ward's method. To identify the optimal number of clusters (K), we considered silhouette statistics, dendrogram inspection, and comparisons and interpretations among the most plausible cluster solutions. Two-tailed nonparametric pairwise comparisons between the obtained clusters were performed at the 5% significance level. All analyses were performed in *R* 4.2.3 (*R* Core Team, 2023) using the following libraries: haven, Likert, dplyr, ggplot2, mice, Rtsne, cluster, factoextra, patchwork, FactoMineR, and Nagpur.

The answers to the qualitative query were analysed using content analysis. The text of the answers was examined using descriptive coding, and frequencies for each code were reported. The first round of coding was performed independently by two authors, and any divergences in the meaning of codes were resolved through discussion. The content analysis was conducted using MAXQDA version 2022.

Ethical consideration

FCSA promoted the study, and the research protocol was reviewed and approved by the FCSA Scientific Committee on 12th October 2023). Given the non-interventional and anonymous nature of the study, formal ethics committee approval was not required under Italian regulations. All data were collected and managed in compliance with the General Data Protection Regulation (EU 2016/679) and Italian Legislative Decree 101/2018, ensuring confidentiality and anonymity of participants.

Results

Sample characteristics

We obtained responses from 59 nurses working at the Italian ACs affiliated with FCSA and 28 referents of the ACs involved. The details of sample characteristics are reported in Supplementary Table 1. Specifically, among the 220 certified Italian ACs by FCSA, we achieved a response rate of approximately 30% ($n = 59$). Regarding the organizational context of the Italian ACs involved, most respondents ($n = 38$, 64.40%) work in Northern Italy and in an intrahospital context. Furthermore, among healthcare professionals working at the Italian ACs, the results showed high heterogeneity in staff composition frequencies. In this regard, nurses are the most represented healthcare profession in the ACs ($M = 3.74 \pm 3.71$), followed by physicians ($M = 2.16 \pm 1.2$) and assistants ($M = 1.42 \pm 1.01$), with a low rate of nursing turnover ($n = 12$, 63.2%). Despite the increased use of DOACs, patients treated with VKAs remain the most treated patients by the Italian ACs (Me = 506, IQ 250–901). Thus, these data reflect the current variation in oral anticoagulant prescribing, with VKAs remaining a therapeutic option in specific scenarios where DOACs are contraindicated [9].

Regarding the socio-demographics and professional profile of the responding nurses, the majority were female ($n = 41$, 85.4%) and engaged ($n = 37$, 77.2%), with a mean

age of 52.25 ± 7.27 years. The overall mean work experience of the responding nurses was 30.29 ± 7.81 years, of which 10.81 ± 6.75 years were in ACs. 98% of respondents reported having a bachelor's degree in nursing, with 87.5% holding a current position as a registered nurse (RN); only 29% of nurses are engaged in clinical research activities at the ACs. Moreover, only 33% of the responding nurses are affiliated with FCSA and 4% with other scientific societies.

t-SNE procedure and clustering procedure

The summary of the relationships between the two stochastic components obtained by the t-SNE procedure is illustrated in Fig. 1. Both scatterplots were generated with the same parameters: a perplexity of 15, a seed of 42, and 1000 iterations. The top panel of Fig. 1 illustrates the distribution of data points before clustering, where each point is uniquely identified by both its size and colour. The size of the points

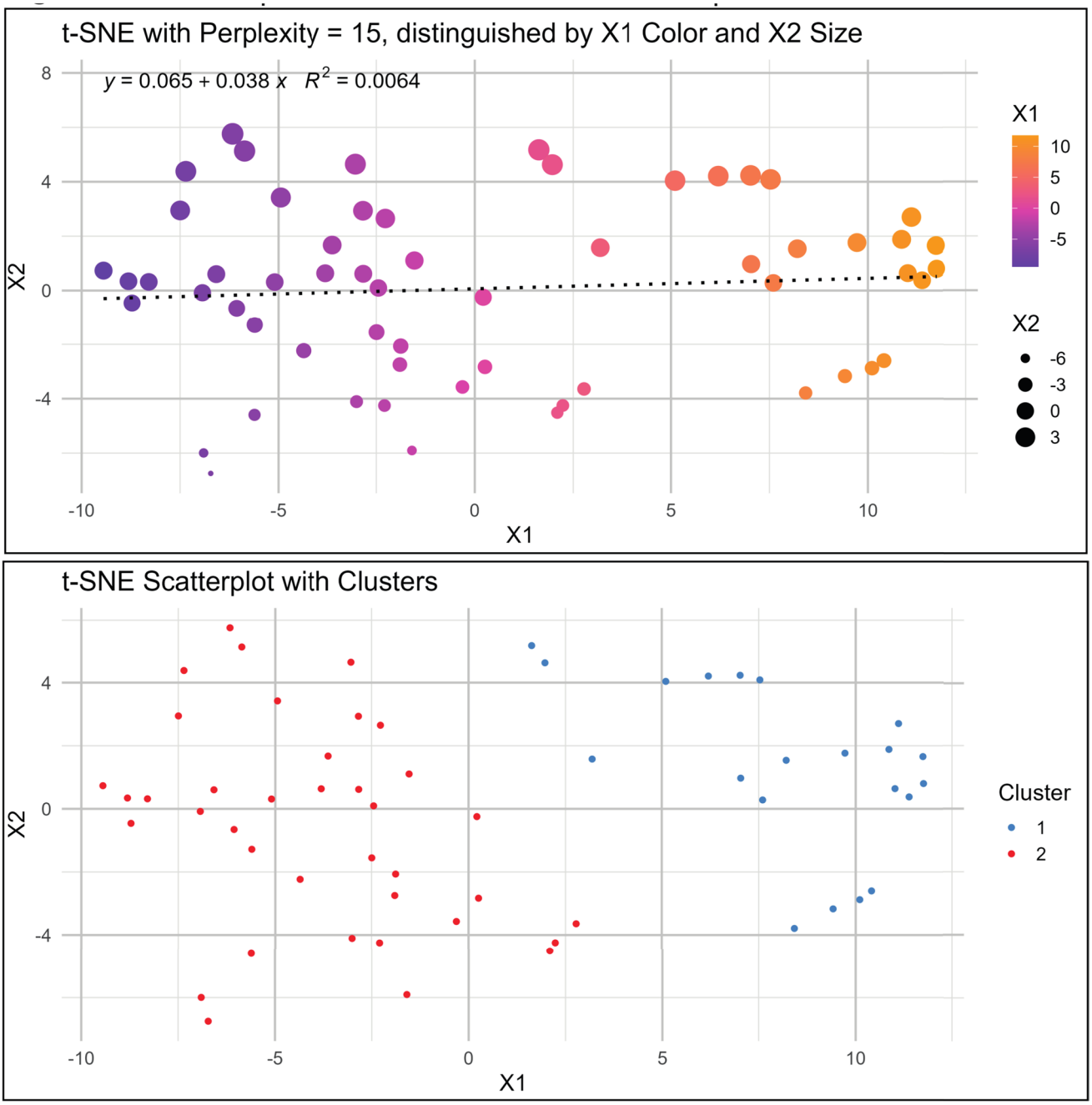

Fig. 1 Scatterplots of the two stochastic components

represents the value of the second stochastic component ($X2$), with larger points indicating higher values. The colour gradient, from purple to orange, corresponds to the values of the first stochastic component ($X1$), with purple indicating lower values and orange higher. The bottom panel displays the same data points after clustering, revealing two distinct clusters and providing a clear separation of the data.

Figure 2 illustrates the dendrogram resulting from the HCA. The branch height and silhouette scores confirmed the presence of two main clusters. Specifically, Cluster 1 ($n = 21$) has a silhouette score of 0.58, indicating strong internal cohesion and clear separation from the other clusters. Cluster 2 ($n = 38$) has a silhouette score of 0.54, also reflecting a good clustering adequacy.

Cluster characteristics

Supplementary File 2 and Supplementary File 3 present the characteristics of the identified clusters, as reflected in the competence and practice profiles of nurses working at Italian ACs. Cluster 1 ($n = 21$) was labelled "substandard practice," while Cluster 2 ($n = 38$) was labelled "proficient practice." The labelling was based on objective criteria, including the cutoffs of the self-report questionnaires used in the e-survey, as well as the percentage distributions of nurses' practices, as described in detail below.

Nursing self-efficacy, job satisfaction, and interprofessional collaboration

Regarding nurses' self-reported level of self-efficacy in managing OAC, there is a significant difference across cluster profiles. Figure 3 reports the comparisons between the clusters. Respondents in cluster 1, labelled as "substandard practice," reported lower and critical levels of self-efficacy across all practice dimensions (Self-efficacy clinical management = 31.25, IQR 18.75–50; self-efficacy care management = 31.25, IQR 18.75–50; self-efficacy education = 11.6, IQR 6.71–29.54; self-efficacy care monitoring = 25, IQR 0–50; self-efficacy clinical monitoring = 0, IQR 0–12). On the contrary, respondents in cluster 2, labelled as "proficient practice," reported higher and optimal levels of self-efficacy across all dimensions (self-efficacy clinical management = 81.25, IQR 62.50–100; self-efficacy care management = 81.25, IQR 62.50–100; self-efficacy education = 72.72, IQR 51.13–90.90;

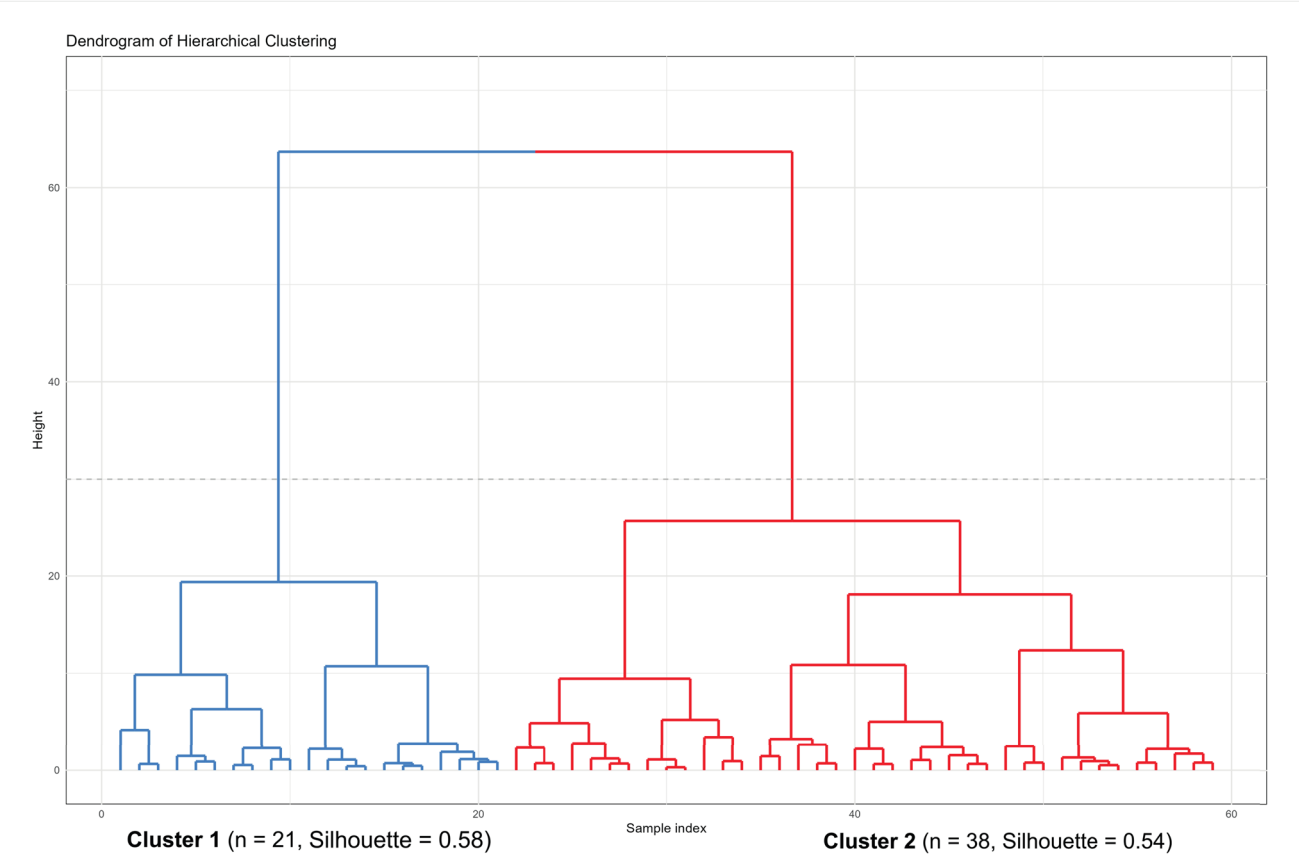

Fig. 2 Dendrogram

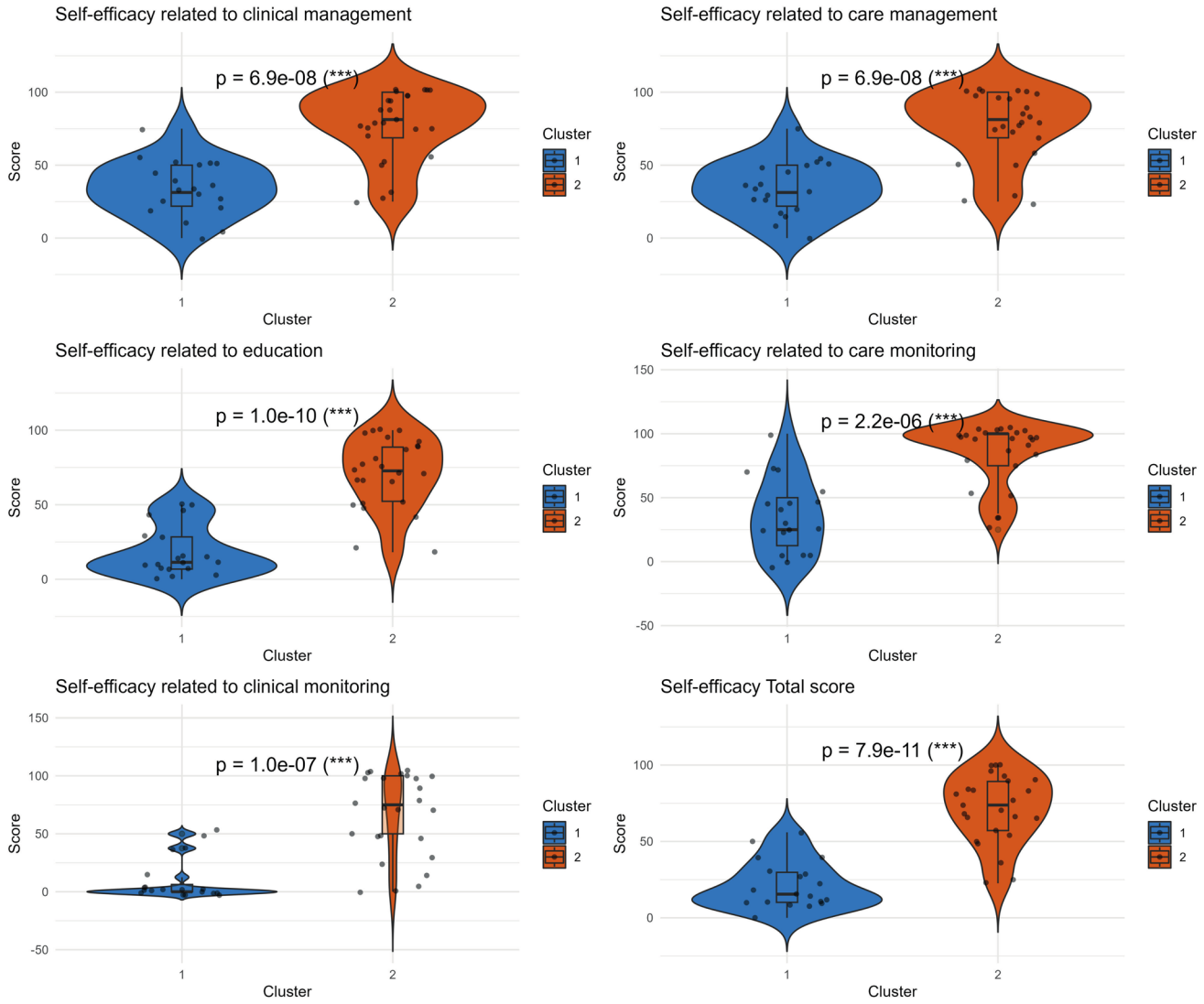

Fig. 3 Comparisons between the clusters

self-efficacy care monitoring = 100, IQR 75–100; self-efficacy clinical monitoring = 72, IQR 37.50–100). Thus, considering a standardized score range from 0 to 100, where values equal to or higher than 70 indicate an adequate level of self-efficacy, the respondents of cluster 2 present a proficient profile, showing higher confidence in comprehensively managing OAC (self-efficacy total score = 73.8, IQR 55.35–89.88) compared to the respondents of Cluster 1, who present a substandard confidence level in managing OAC (self-efficacy total score = 15.47, IQR 9.52–30.95) ($p < 0.001$). The SE-OAM demonstrated excellent internal consistency across all dimensions: clinical management ($\alpha = 0.949$), care management ($\alpha = 0.924$), education ($\alpha = 0.961$), care monitoring ($\alpha = 0.972$), clinical monitoring ($\alpha = 0.981$), and the overall SE-OAM total score ($\alpha = 0.982$). The two cluster profiles also differ in the perception of job satisfaction and interprofessional collaboration. Respondents in Cluster 2 reported higher levels of job satisfaction ($M = 5.83 \pm 1.011$) compared to respondents in Cluster 1 ($M = 3.5 \pm 1.5$) ($p < 0.001$). Regarding interprofessional collaboration, an adequate level is indicated by values of 4 or higher out of 5. Accordingly, respondents in Cluster 2 reported adequate values ($\geq$ four) of interprofessional collaboration across all dimensions (partnership = 4.5, IQR 4.10–4.84; cooperation = 5, IQR 4.28–5.00; coordination = 4.71, IQR 4.05–5.00), while the respondents in Cluster 1 reported inadequate values (≤ 4) of interprofessional collaboration for all dimensions (partnership = 2.5, IQR 1.68–3.03; cooperation = 3.18, IQR 2.96–4.03; coordination = 3, IQR 2.10–3.47).

Nurse practices and OAC education

Figure 4 shows the distribution of responses on a Likert scale by cluster for each activity performed by nurses in the ACs. Overall, the respondents in Cluster 1 reported low frequencies for almost all inquired activities, with responses ranging from "never" or "rarely" in 10–86% of the cases. More specifically, within Cluster 1, nurses' engagement in clinical research and consultation with patient associations were the least frequently performed activities, with 86% and 81% of respondents, respectively, reporting that they never or rarely engaged in them. In Cluster 2, the same activities were also critical but less frequently unpractised, with 58% and 32% of respondents indicating they never or rarely performed them. Furthermore, there were substantial differences in the frequency of clinical assessment, health education, and care monitoring practices across the clusters. For example, only 15% of respondents in cluster 1 included health education in their daily work activities at the ACs, whereas 88% of respondents in cluster 2 regularly underwent health education. Focusing on health education topics to improve OAC management and adherence reveals several differences between clusters. Figure 5 reports the results of health education practice for patients with VKAs. Thus, health education on drug management and monitoring practices and the promotion of a self-management approach by patients and their families were the least addressed topics by respondents in CLUSTER 1. Respectively, 42.1–52.6% of the nurses had never or rarely performed these activities. The respondents in cluster 1 addressed other educational topics occasionally, with frequencies ranging from 5 to 52%. In contrast, respondents in cluster 2 regularly addressed VKA-related educational topics in their clinical practice, with frequencies ranging from 74 to 100%.

Figure 6 reports the results of health education practice for patients with DOACs. Solely for the educational topics on promoting healthy lifestyles, medication adherence, and preventing drug-related risks, respondents in cluster 1 reported regularly practising these behaviours in their routine, with frequencies ranging from 33 to 38%. On the other hand, respondents in cluster 2 stated that they regularly address all educational topics, with frequencies ranging from 79 to 89%. Only 16 nurses answered the qualitative research query. Through content analysis, eight descriptive codes were identified, resulting in a total code frequency of 23. Among these codes, two main barriers to nurse recognition within the staff employed in ACs were identified. The first barrier concerns the lack of recognition of the nurse's role in OAC management and clinical research activities within the AC staff by the internal organizational structure and other professional categories (frequency code 8/23). One respondent also highlighted that the role of ACs is sometimesunderrecognized. The second barrier concerns the paucity of specialized educational pathways for nurses to stay up to

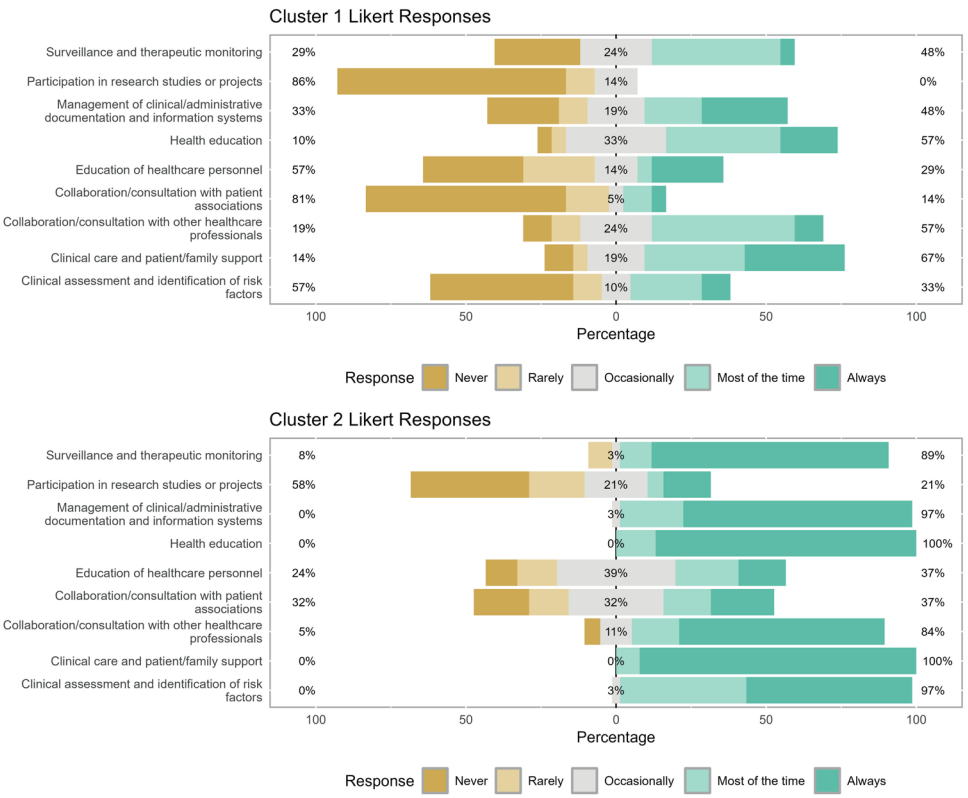

Fig. 4 Nurse practices and OAC education: distribution of responses by clusters

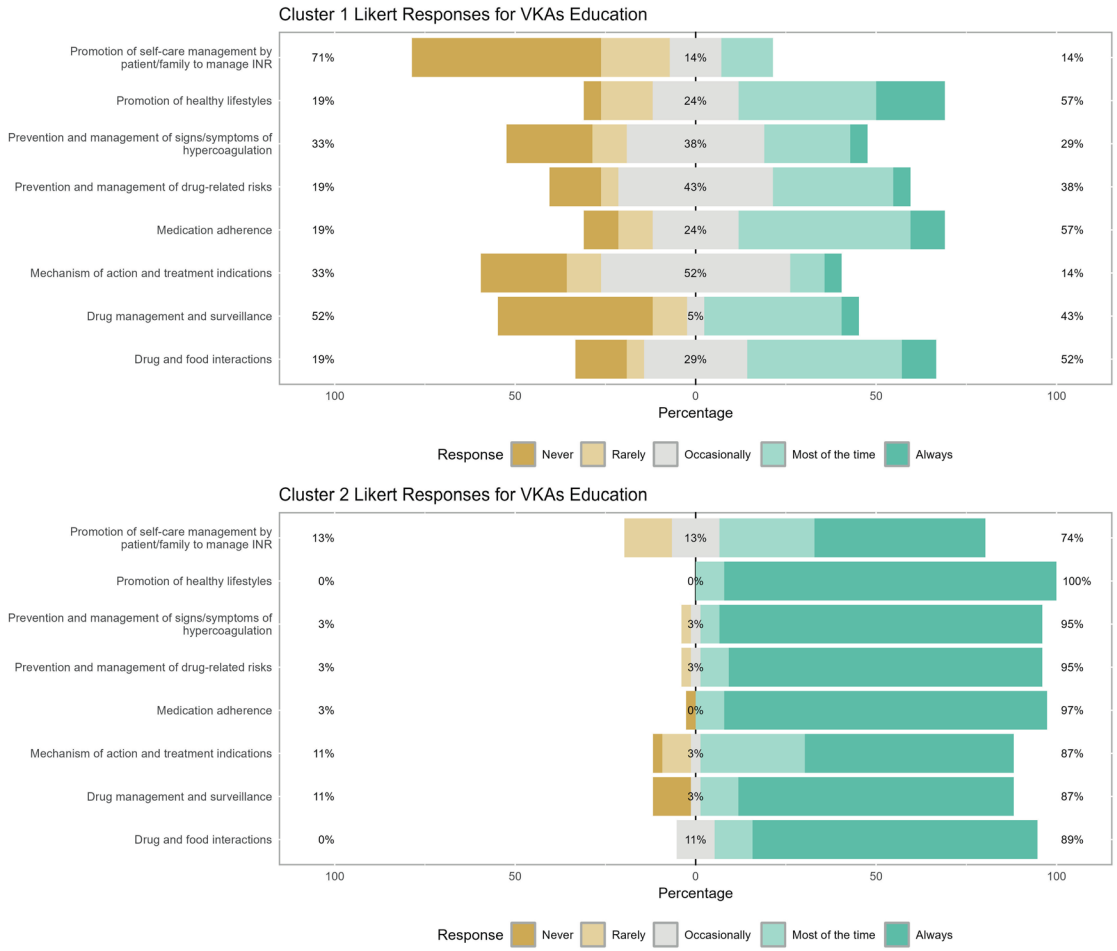

Fig. 5 Health education practice for patients with VKAs: distribution of responses by clusters

date on anticoagulation care (frequency code 7/23). Other less impactful barriers identified include nursing turnover, lack of collaboration, and lack of time during daily practice.

Discussion

The results of this study provide preliminary evidence regarding the competence profile and practices of nurses in OAC management within Italian ACs affiliated with the FCSA. None of the major European surveys has yet investigated the knowledge and management practices of OAC among Italian nurses [18, 20, 21]. Two main clusters were identified: the first represents a profile of nurses defined as "substandard practice" (Cluster 1), while the second represents a profile of nurses defined as "proficient practice" (Cluster 2). Significant differences existed between the two clusters for all nursing practices and competence measurements investigated. As for socio-demographic and professional profile variables, the two clusters appear comparable, with no significant differences in age, sex, role position in ACs, educational profile, or years of work experience.

The profile of nurses in the "substandard practice" cluster showed several education and practice gaps in OAC management. They exhibited critical levels of nursing self-efficacy, but reported low levels of job satisfaction and interprofessional collaboration. On the other hand, nurses in the "proficient practice" cluster demonstrated higher levels of nursing self-efficacy and achieved adequate levels of job satisfaction and interprofessional collaboration. Accordingly, their adherence to nursing practices in anticoagulation care was significantly higher in routine clinical practice compared with nurses in Cluster 1. These findings corroborate Bandura's social cognitive theory, highlighting the pivotal role of self-efficacy as a proxy measure and predictor of nurses' competence in task-specific performance [13].

In this scenario, differences in nursing performance in OAC management could compromise the uniformity of standardized, high-quality care provided by ACs and patient safety [18, 20]. The literature offers syntheses of evidence addressing the impact of advanced nursing practice and

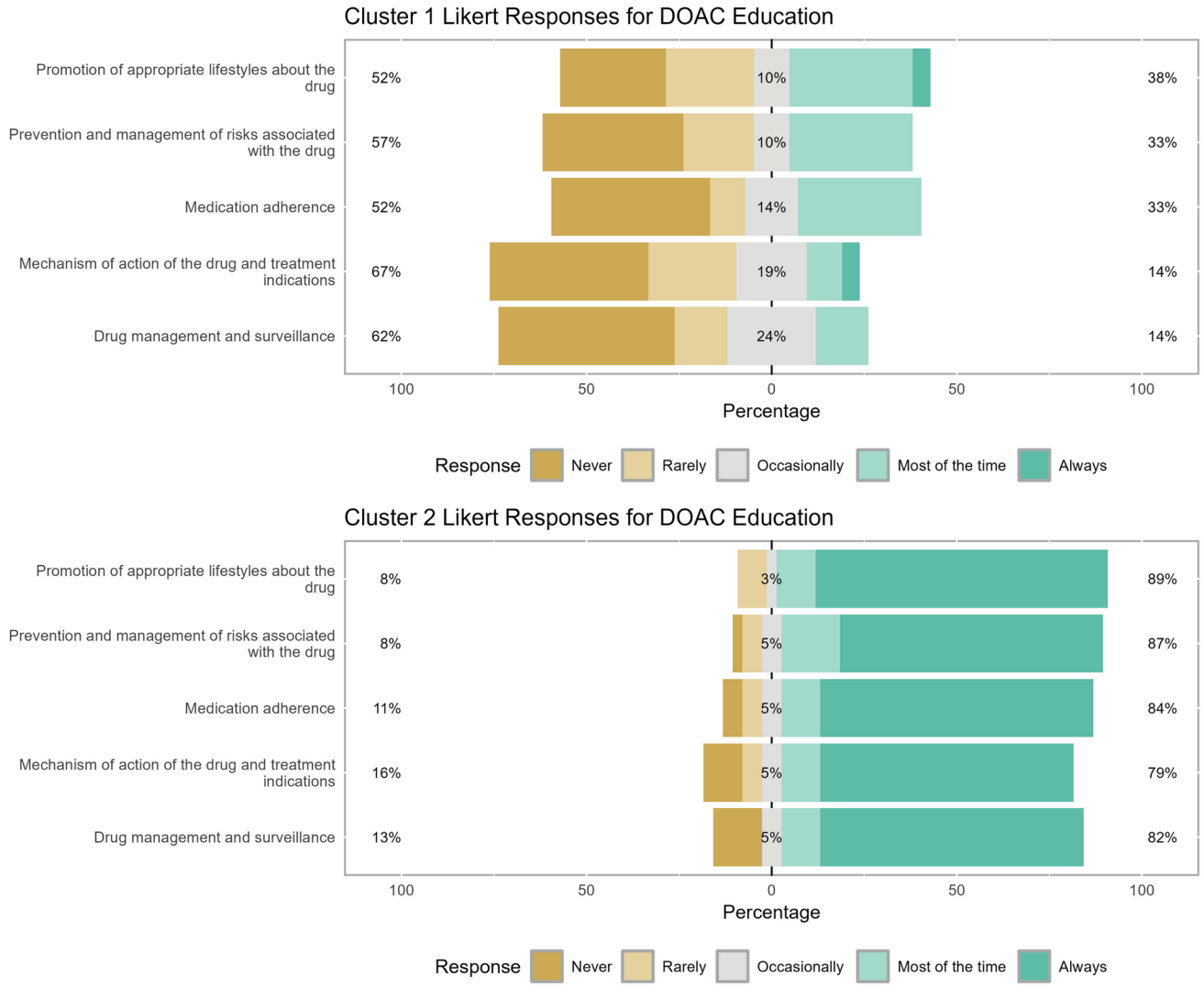

Fig. 6 Health education practice for patients with DOACs: distribution of responses by clusters

nurse-led interventions in OAC management on patient outcomes (e.g. improved patient knowledge, therapeutic adherence, time in therapeutic range, and reduced risk of adverse outcomes) [9, 13]. However, the evidence on the real-world impact of low nursing performance is limited. This gap in the literature highlights the importance of promoting nursing documentation of nurse-led interventions and related outcomes in OAC management, while monitoring the potential consequences for patient outcomes when such nursing practices are inadequate or absent.

We suggest that these results reflect heterogeneity in the uptake of clinical recommendations on OAC use and in practice patterns among healthcare professionals and regional healthcare services [29, 30]. Specifically, regarding the organizational care in OAC management delivered by Italian ACs, a recent study by Tripodi et al. highlighted variability among ACs in the provision of clinical care and laboratory monitoring for patients treated with DOACs [31]. Even for VKA management, the availability of point-of-care coagulation testing (POCT) and computer-based support systems for OAC dosing and monitoring was not equally distributed across the ACs [32, 33]. Thus, the unwarranted variation in organizational care for OAC management could lead to the development of high- and low-performing ACs [1, 12]. According to the Anticoagulation Forum's position statement, nine quality dimensions are considered related to AC performance [11]. Thus, high-performing ACs are characterized by adequate and qualified staff, effective integration of support personnel, innovation aimed at standardizing clinical practice based on evidence-based guidelines, a supportive organizational climate that encourages group learning and collaboration, and the presence of internal performance measurements [11, 12].

Focusing on the workforce of ACs, ensuring personnel qualifications, and providing continuing education programmes for healthcare providers are priorities for the FCSA in delivering a coordinated anticoagulation management programme across affiliated ACs [2]. However, based on our study, 97% of the overall nurse sample holds a bachelor of science in nursing (BScN), and 87% are employed as registered nurses (RNs) within ACs. Thus, the performance of proficient nurses in Cluster 2 is likely attributable to their extensive clinical experience in managing OAC, despite lacking any additional specialization or licensure. Additionally, only 33% of the respondents were affiliated with the FCSA as healthcare professionals. In this context, it becomes crucial to retool nurses' roles within ACs and determine how nursing practices can contribute to achieving the goals of the FCSA, such as promoting educational programmes to increase patient adherence, designing follow-up programmes, and improving coordination among AC services Table 1.

The literature indicates that OAC management requiresspecialized, advanced practice nursing [14, 15, 19, 34]. According to the International council of nurses (ICN) credentialing definition, a nurse practitioner/advanced practice nurse is an RN who has acquired expert knowledge, complex decision-making skills, and clinical competencies to expand the scope of nursing practice [35]. However, in Italy, the recognition of advanced practice through a master's degree is still ongoing and has not yet been fully accredited [35, 36]. Nurses perceive the lack of specific knowledge and expertise as a barrier to the advancement and recognition of their professional role within the AC staff [32, 37]. Therefore, it is strategic for the FCSA, in partnership with universities, to provide postgraduate education courses for nurses to enhance their practice in OAC management and promote their engagement in clinical research.

These postgraduate nursing education programmes should be based on a core curriculum for advanced practice nurses in OAC management, focusing on four key pillars: clinical practice, research, education, and management/leadership [14, 34]. Furthermore, green and digital competencies should be integrated into the curricula of nurse specialists [38]. Investing in nursing education programmes can significantly improve the quality of anticoagulation care, offering more opportunities to attract and retain nurses in the healthcare workforce [38]. Furthermore, considering the challenges faced by the Italian national healthcare system, including increasingly complex patient needs, the retirement of physicians and general practitioners, and a shortage of nurses, it is strategically important to invest in the role of nurses in ACs [39]. Thus, this investment should move toward novel organizational models of skill mix in AC staff, integrating and recognizing advanced nursing practices, and promoting a positive and supportive work environment [7].

The workforce and the organizational models adopted by the ACs require further investigation at both national and European levels [6, 7]. Therefore, the results of this study lay the groundwork for future research aimed at testing the effectiveness of educational interventions in improving nurses' knowledge and practices in OAC management, as well as the effectiveness of nurse-led advanced practice models in achieving better patient outcomes. Based on the available sample data, we have obtained 44.5 full-time equivalent (FTE) nurses to manage an average of 3482.5 patients per AC. Thus, we can hypothesize that approximately 166 FTE nurses would be needed to cover the entire network of 220 ACs in Italy [calculated as FTE by multiplying the sample/proportion of ACs (59/220) by 0.268 ≈ 166 FTE nurses]. In our sample, we observed significant variability in staff composition in ACs. Specifically, the presence of nurses in ACs ranged from zero (10.5%) to 16 (5.3%) per centre. Although larger ACs may require more nursing staff, it is concerning that some organizational settings lack nursing staff entirely. Thus, assuming 116 FTE nurses for 220 ACs, roughly one FTE nurse per centre should be guaranteed as the minimum staffing criterion. We suggest interpreting these reflections on nurse staffing with caution, as they are based on an interim data analysis that may underestimate the real number of nurses working in ACs. Furthermore, we lack sufficient information about the workload of other healthcare professionals within the AC staff and detailed insights into internal organizational factors. Therefore, future studies should address and further investigate these hypotheses, which are crucial for defining safe and quality staffing parameters in the management of OAC.

This study presents several limitations. First, we obtained a low response rate from only 30% of the ACs, limiting the generalizability of the results. Additionally, the data were collected through self-report questionnaires. Thus, the respondents may have overestimated or underestimated their self-assessment of competence and knowledge in managing OAC, potentially influencing the accuracy of the findings. Using a snowball sampling method may have introduced selection bias, as participants might have referred colleagues with similar perspectives or experiences, potentially skewing the results. Furthermore, the cross-sectional design captures data at a single time point, limiting our ability to infer causality or observe changes over time. Lastly, the cluster-based solution requires future investigation to validate the emerging two-cluster structure and guide cluster-specific interventions.

Conclusion

This study provides valuable insights into the competence profiles and practices of nurses managing OAC in Italian ACs affiliated with the FCSA. Identifying two distinct

Table 1 Description of the sample characteristics

Nurse ($n=59$)		
	M	± SD
Age (years)	52.25	7.27
Years of working in patient care	30.29	7.81
Years of working in ACs	10.81	6.75
	N	%
Sex (female)	41	85.4
Marital status (engaged)	37	77.1
Education		
Bachelor's degree	47	97.9
Master's degree	0	0
Postgraduate certification in the cardiovascular field	1	2.1
PhD	0	0
Current position		
Staff nurse/registered nurse	42	87.5
Head nurse/nurse manager	4	8.3
Nurse case manager	2	4.2
Nurse researcher	0	0
Work location (intra-hospital)	48	100
Workload (full time)	41	85.4
Work contract (indeterminate)	46	95.8
Engagement in clinical research (yes)	14	29.2
Role in clinical research (data entry)	7	46.7
Affiliated with FCSA (yes)	16	33.3
Affiliated with other scientist societies (yes)	2	4.2
Description of ACs locations ($n=59$)		
	N	%
ACs in Northern Italy	38	64.40
ACs in Central Italy	8	13.57
ACs in Southern Italy and the Islands	13	22.03
Description of ACs staff ($n=28$ referents)		
	Min (%)	Max (%)
Number of nurses for ACs (mean 3.74 ± 3.71)	0 (10.5)	16 (5.3)
Number of physicians for ACs (mean 2.26 ± 1.2)	1 (26.3)	5 (10.5)
Number of assistants for ACs (mean 1.42 ± 1.01)	0 (15.8)	4 (5.4)
Number of patients on VKAs (median 506, IQ 250–901)	60 (5.3)	4000 (5.3)
Number of patients on DOACs (median 500, IQ 50–674)	0 (15.8)	2962 (5.3)
	N	%
Nursing turnover in ACs (low)	12	63.2

ACs anticoagulation clinics, *OAC* oral anticoagulation therapy, *VKAs* antagonists of vitamin K, *DOACs* direct oral anticoagulants, *FCSA* federazione centri per la diagnosi della trombosi e la sorveglianza delle terapie anticoagulanti

clusters—substandard practice and practice—highlights meaningful variations in nursing self-efficacy, practices, job satisfaction, and interprofessional collaboration, which could impact the uniformity and quality of care delivered by ACs and guide future cluster-based educational interventions. Further investments in nursing education and organizational models are warranted to integrate advanced nursing practice in OAC management. Validating these findings and addressing gaps in our understanding of staff composition, workload, and internal organizational factors is necessary

to define organizational parameters that ensure safe, high-quality OAC management across the ACs.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11739-026-04312-2.

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Data Availability The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Human and Animal Rights This study was conducted in accordance with ethical standards and did not involve any experiments on humans or animals. As the research consisted of an anonymous online survey among healthcare professionals and did not include patient data, formal ethical approval was not required according to local regulations.

Informed Consent Participation in the study was voluntary. Completion and submission of the anonymous questionnaire were considered as implicit informed consent. No identifiable personal information was collected, and participants were informed about confidentiality and the purpose of the study before beginning the survey.

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