



# REVIEW



## The application of the Hub & Spoke model to healthcare support in the Italian Army

L'applicazione del modello Hub & Spoke al supporto sanitario nell'Esercito Italiano

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**Abstract:** In 2023, the Italian Army reorganized its healthcare system by adopting a multi-hub Hub & Spoke model. Fourteen Military Regional Infirmaries were established as centres of reference. This review analyses the application of this model in healthcare and highlights its benefits and challenges. The model improves service accessibility, optimizes resources, and ensures high standards of care, but presents challenges related to hub overload and the coordination of spoke structures. In the military context, it has been adapted to balance the centralization of expertise with the territorial distribution of services. Data collected in the first years of implementation will be essential to assess its effectiveness and enhance its efficiency.

**Riassunto** - Nel 2023, l'Esercito Italiano ha riorganizzato il proprio sistema sanitario adottando un modello Hub & Spoke multi-hub, istituendo quattordici Infermerie Presidiarie come centri di riferimento. Questa revisione analizza l'applicazione del modello in ambito sanitario, evidenziandone benefici e criticità. Il modello migliora l'accessibilità ai servizi, ottimizza le risorse e garantisce elevati standard di cura, ma presenta sfide legate al sovraccarico degli hub e al coordinamento delle strutture spoke. Nel contesto militare, è stato adattato per bilanciare la centralizzazione delle competenze con la distribuzione territoriale dei servizi. I dati raccolti nei primi anni di applicazione saranno fondamentali per valutarne l'efficacia e migliorarne l'efficienza.

**Key words:** military medicine, organizational models, health care support, army.

### Key messages:

- The establishment of Military Infirmaries has allowed the Italian Army Medical Corps to adopt a Hub & Spoke model, optimising the distribution of healthcare resources distribution and guaranteeing a greater coverage in the provision of specialised services.
- The strategic coordination of the Hub, the standardization of protocols and the integration of competencies are the key elements of the model, contributing to the balance between operational efficiency and service accessibility.

### Introduction

At the beginning of 2013, after an experimental phase hampered by the Covid-19 pandemic, the healthcare support to the Italian Army personnel in the national territory underwent a significant organizational transformation with the establishment of fourteen Military Infirmaries.

This reorganisation took place in response to changes in forensic and occupational medicine regulations and the transformation of the National Healthcare System towards local healthcare and the subsequent development of nursing, technical and rehabilitation healthcare professions.

The Military Infirmaries are directly

subordinated to the Health Division of the Army Health and Veterinary Command, under the control of the Army Logistics Command. They provide healthcare support to the local Army entities and are equipped with all the necessary resources needed for the coordination and/or the direct managing of a number of activities. Some examples are

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healthcare assistance for training and operational activities, specialised ambulatory activities for eligibility purposes (cardiology, optics, otolaryngology, orthopaedics, psychiatry, and psychology), laboratory diagnostics (where applicable), hygiene, preventive medicine, forensic and occupational medicine (1). These activities are carried out in network with the institutions healthcare services following the Hub & Spoke model in which the Military Infirmaries serve as hub structures, while the Units' Infirmaries represent the Spoke structures.

The Hub & Spoke model is a healthcare organization that includes a main centre (Hub), provided with a full range of services, connected to secondary facilities (Spoke) that provide basic services and refer patients to the Hub in case of more complex medical necessities. In contexts where geographical distances make transfer between spokes and hubs impractical, it is possible to establish multiple hubs, creating a multi-hub healthcare network (2).

This model was first employed in the air transport sector: in 1955, Delta Airlines used Atlanta airport as its main hub, increasing the frequency of connections with medium and small cities, preferring them to a few direct long-distance routes (3). In the healthcare sector, the report by Royal Army Medical Corps doctor, Bertrand Dawson, is a precursor of the model. In 1920, he suggested a hierarchical assistance system with main healthcare hubs, providing specialised services and secondary centres with basic functions (4). Since then, the Hub & Spoke model has been implemented not only in the healthcare sector (5, 6) but also in other fields, like trade and education, adapting it to the needs of providers and patients to ensure a balance between

territorial coverage and rapid access to services.

### Objective

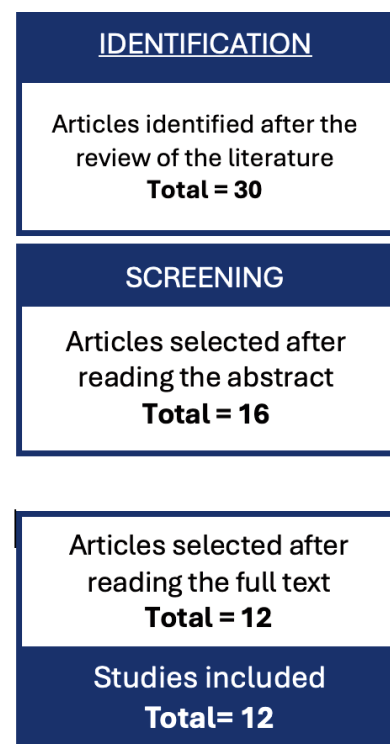
The objective of this article is to analyse the experience in implementing the Hub & Spoke model in the healthcare sector, with particular reference to its employment as a direct support system for the Italian Army. The aim is to identify the distinctive characteristics of the model, the essential elements for its effectiveness and the benefits for patients and service providers. This will, in turn, allow us to assess the new organizational structure of military healthcare and its potential impact on the efficiency and quality of the health assistance for Italian Army personnel.

### Materials and Methods

Bibliographic research was conducted on the PubMed database using the keywords "Hub & Spoke" and the mesh terms "models, organizational", limiting the analysis to articles published after 2010. The research yielded thirty (n= 30) results, of which twelve (=12) were selected after reading the full text. **Figure 1** illustrates the selection process of the articles included in this study. Works that did not describe the effects of the application of the Hub & Spoke model were excluded. The limits of this review are: 1) the use of a single database; 2) the selection of the articles was conducted by a single actor.

### Results

**Chart 1** summarises the articles included in the review, reporting their references, objectives, outcomes and findings according to the PICO model. Five studies



**Fig. 1** - Flow chart review.

were conducted in Italy (7-11), three in the United States of America (2, 12, and 13), two in Australia (14, 15), one in England (16), and one in India (17). Six studies describe the application of the Hub & Spoke model in the management of certain diseases such as congenital heart disease (8), opioid use disorder (12) and liver transplantation (16); three studies deal with prevention (10, 11, 14), two analyse the model in general terms (2,15), and one concerns the rehabilitation sector (7). In all studies, the Hub & Spoke model proved to be efficient and safe. Some researches highlighted its effectiveness in providing a greater number of healthcare services in suburban or remote areas (15, 17) and for the benefit of vulnerable populations (10, 12); other studies have demonstrated economic savings in the provision of services (7, 13).



**Tab. 1** - Studies included in the PICO review .

Title (author - year)	Objective	Outcome	Conclusions
The changing configuration of hospital systems: centralization, federalization, or fragmentation?(Burns et al, 2012) (18)	Analyse whether, between 1970 and 2010, US hospital systems became more centralized or decentralized and understand the dynamics of change underway and their potential implications for the effectiveness and efficiency of the healthcare system.	In the 2000-2010 period, the US hospital system showed a general trend towards fragmentation with a slight shift towards centralization in the last years. However, Hub & Spoke models showed a greater tendency to centralization in comparison to other models.	The study found that hospital systems that operate at local or regional level and adopt a Hub & Spoke model are more capable of centrally coordinating their services. Conversely, larger systems spanning multiple states tend to decentralise or fragment. The fragmentation of the system can hinder the political objectives pursued in the healthcare reform, such as the creation of accountable care organizations.
Innovation technology in neurorehabilitation: introducing a hub and spoke model to avoid patient «migration» in Sicily (Calabrò et al. 2020) (7)	Describe and evaluate the effectiveness of a Hub & Spoke model in providing high-level robotic neurorehabilitation to Sicilian patients, with a particular focus on reducing costs and improving functional outcomes,	The preliminary results of the study show that the model is effective in reducing patients' migration and improving access to robotic neurorehabilitation in Sicily. In particular, a reduction in costs for the regional healthcare system of approximately 260.000 euros was recorded in the province of Messina.	The study concludes that the Hub & Spoke model represents a promising strategy to improve access to and quality of robotic neurorehabilitation in Sicily, while reducing costs for the regional healthcare system. However, further studies are necessary to evaluate the long-term effectiveness of the model and to identify the best strategies for its large-scale implementation.
Gene therapy for people with haemophilia B: a proposed care delivery model in Italy. (Castaman et al. 2024) (19)	Provide a general overview of the topic and an agreement between the authors on the necessity of a Hub & Spoke model to treat haemophilia.	The study highlighted the need to follow the Hub & Spoke organizational model for the delivery of gene therapy for haemophilia B in Italy. The central role of multidisciplinary teams, laboratory monitoring, and patient follow-up is essential to ensure the efficiency and safety of the therapy.	In conclusion, it is essential to ensure that haemophilia centres are adequately organized, equipped, and staffed to select patients, deliver gene therapy, and perform follow-up efficiently and safely. The Hub & Spoke model, together with the involvement of multidisciplinary teams and the implementation of standardized protocols, can help improve access to and quality of the gene therapy for patients with haemophilia B in Italy.
Lombardy regional urgent reorganization for congenital cardiac patients following the Covid-19 pandemic. (Chessa et al., 2020) (8)	Describe and evaluate the effectiveness of the Hub & Spoke model, during the Covid-19 pandemic, to ensure treatment continuity to congenital cardiac patients, minimising the risk of exposure to infection.	The model resulted effective in ensuring treatment continuity to patients with congenital heart disease, with a good clinical outcome and no increase in mortality. During the assessed period, no patients nor parents tested positive to COVID-19. However, some healthcare professionals have tested positive, highlighting the need for adequate availability of personal protective equipment.	The study concludes that the Hub & Spoke model is an effective strategy to manage patients with congenital heart disease during the COVID-19 pandemic. The authors emphasize the importance of collaboration between Hub & Spoke centres, the adoption of infection prevention measures, and the planning of the management of future emergencies.
Hub & Spoke model: making rural healthcare in India affordable, available and accessible.(Devarakonda, 2016) (20)	Evaluation of the Hub & Spoke model in the Indian healthcare sector in expanding healthcare coverage, increasing profits and reducing operating costs for healthcare organizations and, subsequently, for patients.	The study highlights that the Hub & Spoke model, when combined to ITC resource use, enables the delivery of medical care even in the most remote rural areas, using modern procedures and equipment at a nominal cost for the end user. The model eliminates the need for unnecessary travel and keeps costs low for medical facilities and patients.	The Hub & Spoke model is an effective mechanism for the delivery of healthcare services in rural areas, as it improves access to care, reduces costs, and uses resources efficiently. The use of technological resources is fundamental to the success of the model, as it facilitates communication and data transfer between Hubs and Spokes.

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Title (author - year)	Objective	Outcome	Conclusions
Networked dental services in remote areas: a viable and sustainable approach to oral health care in challenging environments.(Dyson et al., 2012) (14)	Evaluate effectiveness in terms of costs for a dental service model in remote areas, with particular attention to oral care and the indigenous populations in western Australia.	The results of the study showed that the Hub & Spoke model has an average cost-value ratio of 1.61, which is comparable to that of large-scale government service models. The model also provided 8,712 dental services to over 3,500 patients, 94% of whom were indigenous.	The Hub & Spoke model is a cost-effective way to provide dental services in remote areas, particularly for indigenous populations. The model offers a number of advantages, including cost-effectiveness, continuity of care, cultural sensitivity, and training opportunities. The study suggests that other health disciplines in other remote area settings could apply the same model.
The Hub & Spoke organization design: a way of serving patients well.(Elrod & Fortenberry, 2017) (2)	Describe and discuss the advantages of the Hub & Spoke model for the provision of healthcare services, using as an example the service delivery network of the Willis-Knighton Health System, which has used this model for over three decades.	The Willis-Knighton Health System experience has confirmed the advantages of the Hub & Spoke model, demonstrating that it can enable efficient growth, improved quality of care, and increased market coverage.	The Hub & Spoke model is a valid option for the organization and delivery of healthcare services, capable of supporting healthcare institutions in their commitment to providing the best possible service to patients.
The development of a Hub & Spoke network for trans catheter aortic valve replacement procedures: the operational model of the Interventional Cardiology Unit at the IRCCS San Raffaele Hospital in Milan to respond to the increase in the number of patients eligible for trans-catheter aortic valve implantation (TAVI).(Ferri et al., 2024) (9)	Describe the Hub & Spoke model implemented in the Interventional Cardiology and Hemodynamics Unit at the IRCCS San Raffaele Hospital in Milan to respond to the increase in the number of patients eligible for trans-catheter aortic valve implantation (TAVI).	The average age of treated patients is 83 years old, and the median Society of Thoracic Surgeons score is 2.4. The most frequently implanted prosthesis is the CoreValve Evolut R (47.2%). Only 2 patients (2.8%) had a prolonged stay at the Hub centre due to complications. The study results show that the Hub & Spoke model is effective and safe, with a low incidence of complications and reduced hospital stays.	The study concludes that the Hub & Spoke model represents a promising strategy for optimizing TAVI treatment, ensuring high standards of quality and safety for patients and improving access to care for the population. However, further prospective, randomized studies are necessary to confirm these preliminary findings and evaluate the long-term impact of the model.
Multi-model implementation of evidence-based care in the treatment of opioid use disorder in Pennsylvania.(Kawasaki et al., 2019) (12)	The study aims to describe the experience of the Pennsylvania Coordinated Medication Assisted Treatment (PacMAT) program at Penn State Health and evaluate the effectiveness of the Hub & Spoke model in increasing access to medication-assisted treatment (MAT) for opioid use disorder (OUD), reducing waiting times, and improving quality of care.	Preliminary results from the study show that the model is effective in increasing access to MAT and reducing waiting times for treatment. In particular, the program trained 70 local doctors to prescribe buprenorphine. In addition, there has been an improvement in the knowledge and skills of healthcare professionals participating in the ECHO Project.	The Hub & Spoke model represents a promising strategy to address the opioid overdose crisis in Pennsylvania. The model increases access to MAT, reduces waiting times, and improves the quality of care. However, further studies are necessary to evaluate the long-term effectiveness of the model and to identify the best strategies for its large-scale implementation.
Service distribution and models of rural outreach by specialist doctors in Australia: a national cross-sectional study.(O'Sullivan et al., 2016) (15)	Describing how service distribution and models of rural outreach vary based on where the specialist rural doctors live, what their field of practice is and what the regional context in Australia is.	Metropolitan specialists (accounting for 58% of specialists), provided almost half of outreach services (585/1401; 42%) to outlying or remote locations. The most common outreach model was drive-in, drive-out (DIDO) (379/902; 42%). In comparison, specialists based in metropolitan areas were less likely to provide Hub & Spoke service models (odds ratio (OR) 0.31; 95% confidence interval (CI) 0.21-0.46) and more likely to provide fly-in, fly-out service models (OR 4.15; 95% CI 2.32-7.42).	Service delivery and outreach models vary depending on where specialists live and what their practice area is. Multi-level policy and planning are necessary to manage the risks and benefits of different service models by metropolitan and rural specialists in order to promote integrated and accessible services.

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Title (author - year)	Objective	Outcome	Conclusions
<p>Treating and caring for migrant populations suffering from infectious diseases: the experience of the Hub &amp; Spoke network set up by the National Highly Specialised Civico Benfratelli Hospital in Palermo (Sicily Region, Southern Italy) (Prestileo et al., 2024) (10)</p>	<p>The study aims to describe the experience of a Hub &amp; Spoke organizational model, active at the National Highly Specialised Civico Benfratelli Hospital in Palermo, and evaluate its effectiveness in ensuring screening, diagnosis, treatment, and follow-up.</p>	<p>The study showed that the model guarantees high screening coverage for major infectious diseases, adequate care and good patient follow-up. The study points out high rates of viral suppression for HIV and cure for tuberculosis. There is a particular focus on social vulnerabilities and linguistic and cultural barriers.</p>	<p>In conclusion, the Hub &amp; Spoke model represents an effective strategy for improving access to and quality of health-care for migrant and vulnerable populations. Collaboration between hospitals and local communities, a focus on cultural mediation and outreach have proven to be key elements.</p>
<p>Haemodialysis at Doorstep - «Hub &amp; Spoke» Model of Dialysis in a Developing Country.(Sahay et al., 2020) (17)</p>	<p>The study aims to describe the characteristics and short-term results of the Hub &amp; Spoke model applied in the treatment of 705 patients undergoing haemodialysis at Osmania General Hospital (Telangana, India) and nine peripheral centres linked to it, highlighting its advantages in terms of access to care and efficient use of resources.</p>	<p>In the study, the average age of patients undergoing haemodialysis was 48.58 years. Most patients (80.5%) had an arteriovenous fistula as vascular access and 55.1% underwent haemodialysis three times a week. Seropositivity for hepatitis C was 14.3%, while for hepatitis B it was 2.1%. The mortality rate was 4.9% after an average dialysis period of 9 months.</p>	<p>The study concludes that the Hub &amp; Spoke model is a promising solution for providing haemodialysis in a developing country such as India, as it improves access to care, optimises the use of resources and ensures good quality of care.</p>
<p>Sexually transmitted infections: a new Hub &amp; Spoke model to control the increasing trend of STIs in Italy and prevent their spread.(Suligoj et al., 2024) (11)</p>	<p>The aim of the study was to develop an innovative model in Italy for sexually transmitted infections' (STIs) prevention, diagnosis, and treatment based on high-quality multidisciplinary centres integrated with local facilities. Moreover, it aimed at defining an integrated care pathway (ICP).</p>	<p>The study highlighted that the Hub &amp; Spoke model is innovative, transferable, and adaptable to different regional contexts in Italy. The trial conducted in three operating units showed improvements in care, connections with specialists, preventive measures, and the provision of information.</p>	<p>The Hub &amp; Spoke model has proven to be more functional for modern STI care in Italy. The model reduces barriers to access services and costs for the community, expands the target population and implements targeted and effective prevention interventions. Based on experience, there is an urgent need to develop a national strategic plan for this type of infection.</p>
<p>Cost-effectiveness of Hub &amp; Spoke tele-stroke networks for the management of acute ischemic stroke from the hospitals' perspectives.(Switzer et al., 2013) (13)</p>	<p>The study aims at determining whether the costs and benefits of a tele-stroke network support its implementation from the point of view of the three main stakeholders (network, hub, spoke). It also evaluates the sensitivity of these results to a range of plausible variations in model inputs in the State of Georgia (US).</p>	<p>The study found that, in the year examined, the Hub &amp; Spoke model allowed the treatment of approximately 45 more patients with intravenous thrombolytic therapy and 20 more with endovascular therapy under a tele-stroke network. It is estimated that it could achieve an estimated cost savings of \$358,435 per year, with a tele-stroke network compared to no network during the first five years. The study also found that hospital costs were particularly sensitive to transfer rates from spoke hospitals to the hub. As the transfer rate increased, the model suggested that cost savings for the network and individual spokes decreased, while they increased for the hub hospital.</p>	<p>The study concluded that a tele-stroke network could increase the number of patients discharged home and reduce costs for hospitals in the network. When developing a network it is important to take into account its economic implications that can vary for individual participating hospitals, depending on available resources and the spoke-to-hub transfer rate.</p>

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Title (author - year)	Objective	Outcome	Conclusions
The Royal Free Hospital 'hub-and-spoke network model' delivers effective care and increased access to liver transplantation.  (Tai et al., 2018) (16)	The study's objective is to assess if the Royal Free Hospital liver transplantation Hub & Spoke networks in London, improve equal access, provide comparable results for patients and influence their satisfaction.	During the study period, they evaluated 655 patients for liver transplantation: 180 (27%) from Spoke centres and 475 (73%) from the Hub. Patients from Spoke centres more frequently had viral hepatitis or hepatocellular carcinoma as indications for transplantation (77.2% vs. 65.7%; P=0.05). Patients from Spoke centres were more likely to be placed on the waiting list than those from the Hub (139/180 vs. 312/475; P=0.005). Waiting list mortality, waiting times for transplantation, and MELD/UKELD scores were equivalent between the two groups (P=0.91). One- and three-year survival rates were also similar (P=0.34). Patient satisfaction was high in both groups, but with a significantly greater preference for local care in Spoke centres (11/50 vs. 70/73; P<0.001).	The study concludes that Hub & Spoke liver transplant networks are effective in delivering equivalent clinical outcomes, high patient satisfaction, and alleviating clinical pressure on the Hub centre. They have the potential to help eliminate geographic disparities in mortality rates for chronic liver disease.

## Discussion

The Hub & Spoke model includes a specialised structure (Hub) linked to secondary centres (Spokes) spread across the territory that provide less complex services. According to the analysed studies, the model has proven to be effective in improving specialised treatment accessibility and optimizing the use of healthcare resources. At the same time, the model guarantees high healthcare and patients' satisfaction standards (16, 18). The key elements of the model are the strategic coordination of the Hub, protocol standardization and competencies integration; all these factors contribute to balancing operational balancing and service accessibility (2, 21). For example, the study by Suligoi et al. developed an integrated pathway for the management of sexually transmitted infections that defines clearly the transition from Spoke facilities to the Hub (11). The Hub is not only a reference for specialized healthcare services; it carries

out a fundamental role in personnel training and in the development of innovative healthcare protocols. The presence of a university hospital as a Hub can also promote teaching and research (16). The Hub & Spoke model centralizes the provision of specialised services, the coordination of spoke facilities, the management of patients' flows and the development of shared clinical protocols. However, the effectiveness of the network depends on the ability that each Hub has to manage these functions in the best way possible, making it necessary to have staff dedicated exclusively to coordinating the provision of healthcare services with spoke facilities. Among criticalities, there is the risk of Hub overload, which could compromise the efficiency of the entire system, or the underutilization of spoke facilities, which risk taking a marginal role. To avoid these derangements, planning the type and volume of services provided in the various structures properly is key: the healthcare the target population needs

and the distance between hub and spokes have an impact on costs and assistance promptness (13).

In the Army's new Healthcare model, Military Infirmaries take on the role of hubs, while Units' Infirmaries act as spoke structures in a multi-hub system coordinated by the Healthcare Division of the Healthcare and Veterinary Command.

The hierarchical relationship between the Health Division and the Military Infirmaries allows for a clear definition of roles and responsibilities:

- The Health Division is responsible for issuing regulations and protocols;
- The Military Infirmaries directly manage healthcare personnel and coordinate specialised and eligibility activities;
- Although the Units' Infirmaries are hierarchically dependent on their respective Departments, they operate under the technical supervision of the Military Infirmaries.



The centralisation of medical staff at the Military Infirmaries led to the efficient reorganisation of medical visits, the rebalancing of outpatient activities at the Hub headquarters and on-site visits at the Units' Infirmaries. The distribution between these two modes varies according to various logistical factors, including the availability of clinics, the distance between locations and the means of transport available. The data collected during the first few years of implementation of this model will be essential to assess its effectiveness and identify any areas for potential improvement, with a view to further

optimising the healthcare services provided to Army personnel (Fig. 2).

### Conclusions

The establishment of the Military Infirmaries has enabled the Italian Army Medical Corps to adopt a multi-hub Hub & Spoke model, with the aim of optimising the distribution of healthcare resources and ensuring greater coverage in the provision of specialised services. However, in order to maximise the benefits of the model, continuous adjustments are necessary to ensure an optimal balance between centralisation of exper-

tise and territorial coverage. To further improve the effectiveness of the system, it may be useful to conduct an in-depth analysis of the distribution of healthcare services among the various structures of the Italian Army, in order to identify the best allocation of resources, refine treatment, and care pathways. The establishment of the Military Infirmaries has enabled the Italian Army Medical Corps to implement a multi-hub Hub & Spoke model, with the aim of centralising medical officers and, at the same time, distributing specialist services across the territory. In conclusion, the Hub & Spoke model has proven to be a valid solution for providing healthcare support to military personnel, allowing for the efficient preservation and restoration of operational health (22).

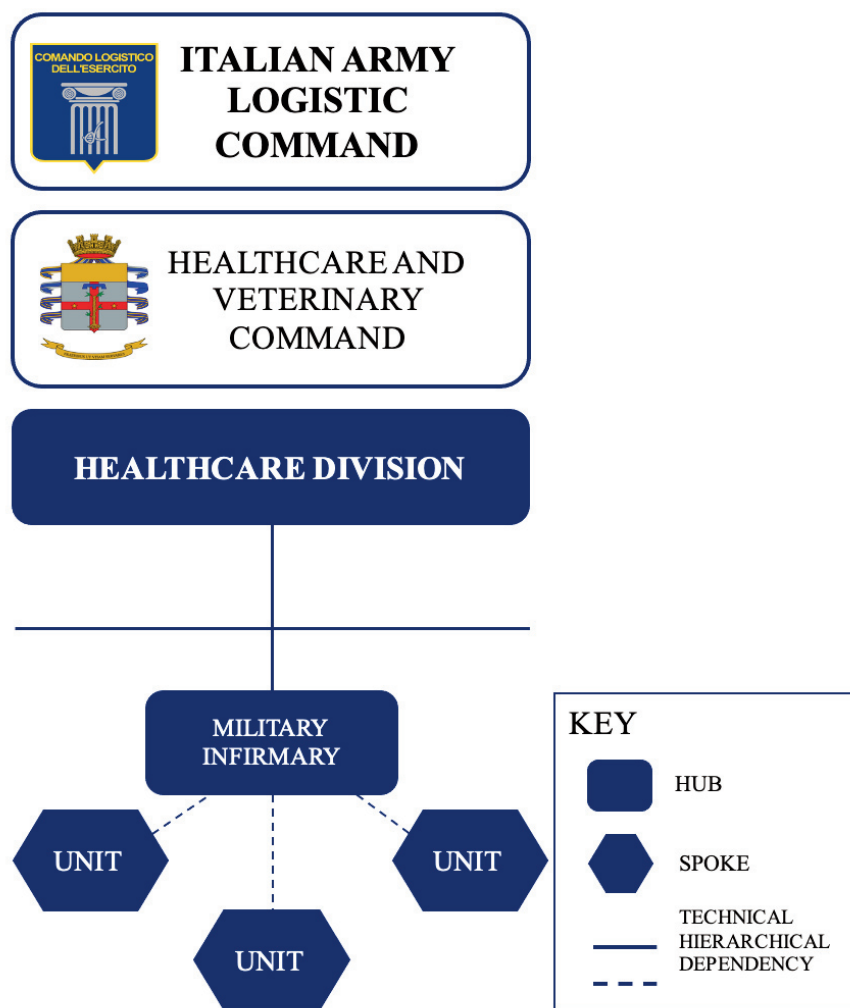


Fig. 2 - The multi-hub network of territorial healthcare support.

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### **Disclosures:**

The Author declares that he has no relationships relevant to the contents of this paper to Disclose.

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