UNIVERSITY OF RIJEKA

FACULTY OF MEDICINE

INTEGRATED UNDERGRADUATE AND GRADUATE UNIVERSITY STUDY OF MEDICINE IN ENGLISH

ALEXANDER FRITZEN

COMPARISON OF PREHOSPITAL EMERGENCY CARE ORGANIZATION IN CROATIA AND GERMANY

GRADUATION THESIS

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Thesis mentor: Professor Vlatka Sotošek, MD, PhD

The graduation thesis was graded on _____ in _____,

before the committee composed of the following members:

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The graduation thesis contains ____ pages, ____figures, ____ tables, ____ references.

Table of content

List of abbreviations and acronyms

AGBF – ger. *Arbeitsgemeinschaft der Leiter der Feuerwehren* (German Professional Fire Service Association)

ALS – Advanced Life Support

ASB – ger. *Arbeiter Samariter Bund* (Workers‘Samaritan Federation)

BLS – Basic Life Support

CAD Systems – Computer-aided dispatch systems

CIEM – Croatian Institute for Emergency Medicine

CNHS – Croatian National Health System

CPR – Cardiopulmonary Resuscitation

DIN – ger. *Deutsches Institut für Normung* (German Institute for Standardization)

DRK – *Deutsches Rotes Kreuz* (German Red Cross)

EMS – Emergency medical services

EMT – Emergency Medical Technician

EN – European Norm

EU – European Union

GIS – Geographical Information System

GKV – ger. *Gesetzliche Krankenversicherung* (Statutory Health Insurance)

HEMS – Helicopter emergency medical service

HZHM – cro. *Hrvatski zavod za hitnu medicinu* (Croatian Institute for Emergency Medicine)

HZZO – Croatian Institute for Health Insurance

IDC – Integrated Dispatch Center

IMSI – Integrated Emergency Medical System

MDT – Mobile Data Terminal

MICU – Mobile Intensive Care Unit

NEF – ger. *Notarzteinsatzfahrzeug* (emergency physician vehicle)

RTW – ger. *Rettungswagen* (emergency medical vehicle)

SGB – ger. *Sozialgesetzbuch* (Social security code)

1. Introduction

Emergency medical services (EMS) are an essential aspect of healthcare systems in every country around the world. Access to timely and appropriate prehospital emergency care can mean the difference between life and death for patients in need. Prehospital care organizations have distinct differences and similarities across different countries, which allows for the identification and comparison of the most effective practices.

This thesis aims to compare prehospital emergency care organizations in Croatia and Germany. The comparison of these two countries is significant due to their differing geographical location, economic system, and healthcare infrastructure. Croatia is a southeast European nation bordering the Adriatic Sea, with a population of approximately 4 million people (1). In contrast, Germany is a central European country, the largest in the European Union, with a population of approximately 83 million people (2). While both countries have their healthcare systems, they are different in many aspects.

In Croatia, prehospital emergency care is regulated and provided by the Croatian Institute for Emergency Medicine (CIEM), which is part of the Croatian National Health System (CNHS). CIEM consists of emergency medical teams that operate throughout Croatia, and it is the primary responsibility of these teams to provide prehospital emergency care (3). In contrast, the German EMS system is regulated by the states, and each state has a different approach to managing EMS operations. Local fire departments or private ambulance companies provide EMS services, with supervision from the state (4).

2. Aims and Objectives

Despite the differences in prehospital emergency care organization, both Croatia and Germany have achieved success in delivering high-quality prehospital emergency care. However, there

are a few fundamental differences that remain unexplored, which this thesis will aim to bring to light. The primary purpose of this thesis is to identify the differences between the two countries' prehospital care organizations in terms of structure, policies and procedures, and resources. Furthermore, this thesis will evaluate how these differences affect the quality and effectiveness of prehospital emergency care provided in the respective countries.

In conclusion, a careful comparison of the prehospital emergency care organization in Croatia and Germany can highlight the strengths and weaknesses of each system. Such a comparison would identify effective practices to be implemented in areas of improvement and identify areas that require improvement. Ultimately, this could lead to a better healthcare system that enhances the quality of life of the citizens of these two countries.

3. Literature review

3.1. Healthcare System overview

3.1.1. Organization structure

3.1.1.1. Organization structure in Germany

In Germany, the organization structure of prehospital emergency services involves a multi-level approach that includes coordination and responsibilities at the federal, state, and local levels.

At the federal level, the Federal Ministry of Health (ger. *Bundesministerium für Gesundheit*) is responsible for setting overall healthcare policies, including guidelines and regulations for emergency medical services (EMS). The ministry provides strategic direction, establishes quality standards, and oversees the implementation of emergency medical care across the country.

Emergency medical services in Germany are primarily organized and managed at the state level. Each of the 16 states (ger. *Bundesländer*) has its own state ministry of health or equivalent authority that governs healthcare-related matters within the respective state. The state ministry is responsible for implementing federal policies and regulations related to EMS within their jurisdiction (5).

At the local level, emergency medical services are coordinated through regional coordination centers known as ger. "*Leitstellen*". These centers are responsible for receiving emergency calls, dispatching appropriate resources, and coordinating the provision of prehospital emergency care within their designated areas. These control centers are typically operated by the state or regional government authorities and serve as the central communication hub for emergency response (6).

Emergency medical services in Germany are provided by various entities, including public and private organizations. These organizations are responsible for delivering prehospital emergency care on the ground. They can include fire departments, charity rescue services, and private ambulance services. The specific organization and management of these services can vary between states and local jurisdictions (7).

Several associations and professional bodies play a role in the organization of prehospital emergency services in Germany. These include the German Aid Services like ger. "*Arbeiter-Samariter Bund* (ASB) or ger. "*Deutsches Rotes Kreuz*" (DRK), the German Professional Fire Service Association (AGB, ger. *Arbeitsgemeinschaft der Leiter der Berufsfeuerwehren*) and professional bodies representing emergency physicians and paramedics. These associations provide guidance, training, and representation for EMS personnel and contribute to the development of standards and best practices in the field (4).

It's important to note that while this provides a general overview of the organization structure of prehospital emergency services in Germany, there may be variations and specific nuances in the implementation and organization at the state and local levels.

3.1.1.2. Organization structure in Croatia

Prehospital emergency care in Croatia is organized and provided by the Croatian Institute for Emergency Medicine (CIEM). The CIEM is a governmental agency responsible for coordinating and managing prehospital emergency medical services in Croatia. The organization structure of prehospital emergency care in Croatia is composed of several levels, each with different roles and responsibilities (8).

At the top of the organizational pyramid is the CIEM, which oversees the entire system. It is responsible for setting the standards and protocols for prehospital care, managing resources, and allocating funding. The CIEM also coordinates emergency response services with other agencies, such as the police and fire departments (3).

Below the CIEM, there are eight regional centers responsible for coordinating and managing emergency medical services in their respective areas. These centers are based in cities across the country and serve as the primary contact for individuals in need of assistance. They serve as a hub for communication and coordination with other emergency response agencies, including hospitals and transport services (9).

Within each regional center, there are dispatch centers that are responsible for receiving emergency calls and dispatching ambulances and other emergency vehicles to the scene. The dispatchers are trained to assess the severity of the emergency and prioritize resources accordingly. They also provide pre-arrival instructions and guidance on first aid procedures to individuals calling for help (9).

Ambulance teams are the primary providers of prehospital emergency care in Croatia. They consist of a driver and an emergency medical technician (EMT) who responds to emergency calls and provide on-site medical assistance. There are two types of ambulances in Croatia - basic life support (BLS) and advanced life support (ALS) ambulances. BLS ambulances are equipped to handle basic medical emergencies, while ALS ambulances are staffed with a physician as their third member of the team, who can provide advanced medical care (10).

The organization structure of prehospital emergency care in Croatia is centralized under the CIEM with regional centers responsible for management and coordination. Ambulances and emergency medical personnel are the primary providers of care, with hospitals and medical facilities playing a supporting role in the system.

3.1.2. Financing models

3.1.2.1. Financing models in Germany

Germany has a decentralized healthcare system, and prehospital emergency care is primarily financed through a combination of public and private funding sources (11).

Most of the German population is covered by statutory health insurance. The costs for prehospital emergency care services are typically covered by these insurance schemes, with patients paying nominal co-payments (e.g., fixed amount per emergency call or percentage of the overall cost) (12–15).

Ambulance services in Germany operate under a fee-for-service system. Providers bill the insurance companies directly for each service provided, including ambulance transport, medical treatment, and equipment used. The reimbursement rates are usually negotiated between the providers and the insurance companies.

Each German state (ger. *Bundesland*) has its own Emergency Medical Services Act, which regulates the provision and financing of prehospital emergency care. The acts establish the responsibilities of the various stakeholders involved, such as the local authorities, emergency medical service providers, and insurance companies (16).

Local authorities, such as municipalities or districts, play a significant role in organizing and financing prehospital emergency care services (17). They are responsible for ensuring adequate coverage, coordinating emergency medical services, and funding the infrastructure, including ambulances and emergency response centers.

3.1.2.2. Financing models in Croatia

Croatia also has a decentralized healthcare system, and prehospital emergency care is financed through a combination of public funds and health insurance contributions.

Croatian Institute for Health Insurance (HZZO, cro. *Hrvatski zavod za zdravstveno osiguranje*) is the primary organization responsible for managing health insurance and financing healthcare services in Croatia. Prehospital emergency care services are typically covered by health insurance, and patients may need to pay co-payments or participation fees for certain services (18).

In Croatia, health insurance is compulsory for all citizens. The contributions to health insurance are based on income and employment status. Prehospital emergency care is one of the services covered by the health insurance system (18).

The organization and provision of prehospital emergency care services in Croatia are primarily the responsibility of individual counties. Each county has its emergency medical services, which are coordinated by local authorities and funded through county budgets (9).

3.2 Concept of care

3.2.1. Concept of care in Germany

In Germany, the concept of prehospital emergency care involves multiple stakeholders and levels of care to ensure efficient and high-quality assistance during emergencies.

The EMS plays a central role in this concept. It is typically activated through the emergency call number 112 and consists of ambulances (RTW) and emergency doctor vehicles (NEF). The personnel in the ambulance service includes qualified paramedics who can provide medical care at the scene (19).

The concept is based on a regional structure, with designated areas covered by ambulance stations. These stations are equipped with ambulances and staffed to ensure a prompt response

to emergency calls (20). In rural areas, helicopter emergency medical services (HEMS) may also be deployed to reach remote locations.

Prehospital emergency care follows specific standards and protocols. Emergency medical service providers are trained to provide initial care and lifesaving measures at the accident scene. They can perform actions such as resuscitation, wound care, and administration of medications.

In severe emergencies, a physician, known as an emergency doctor or ger. "*Notarzt*," may be involved. Emergency doctors have specialized medical training and can perform advanced procedures such as invasive interventions or the administration of specific medications.

The concept also includes coordination with hospitals. Designated hospitals have specialized departments for the admission and treatment of emergency patients. The ambulance service maintains close communication with hospitals to ensure a seamless handover of patients (21).

The prehospital emergency care concept in Germany aims to provide rapid, effective, and high-quality medical assistance during emergency situations. It relies on a well-coordinated interplay between ambulance services, emergency doctors, and hospitals to ensure the best possible care for patients. Once dispatched, the physician is typically able to reach the scene within 10-15 minutes. This rapid response has been shown to improve patient outcomes and reduce the likelihood of long-term complications (22,23).

3.2.2. Concept of care in Croatia

The prehospital care in Croatia is heavily influenced by the European Union (EU) directives and guidelines (20). The CIEM has implemented the EU prehospital care standards, which ensure a high level of quality and safety of the emergency medical services. The emergency medical technicians and paramedics are professionally trained to provide various types of medical interventions, such as advanced life support, basic life support, and transport, using the latest medical equipment, if available.

The prehospital emergency care in Croatia is structured in a way that ensures a rapid response to medical emergencies. The CIEM operates a centralized dispatch system that receives emergency calls and coordinates the response with the regional ambulance stations. The response time is very important, and the CIEM strives to achieve a response time of less than 15 minutes for life-threatening emergencies (24). HEMS are used to care for and transport patients in remote rural regions and the coastal region with the numerous islands in order to ensure the most seamless possible care.

Once the emergency medical team arrives at the scene, they assess the patient's condition and provide the necessary medical interventions. If appropriate, the patient is transported to the nearest hospital for further treatment. The CIEM has established protocols for managing different types of medical emergencies, including trauma, cardiac arrest, stroke, and respiratory distress (25).

The prehospital emergency care in Croatia is funded by the government, and the services are provided free of charge to the patients. The CIEM continuously evaluates the quality of their services and implements improvements based on feedback from patients, health care professionals, and quality assurance programs (24).

3.3. Integration of EMS and other facilities

3.3.1. Integration of EMS and other facilities in Germany

In Germany, the integration of Emergency Medical Services (EMS) with other healthcare providers, including hospitals and primary care centers, is a crucial aspect of the healthcare system.

EMS providers in Germany often work closely with hospitals and primary care centers through a centralized dispatch system. Emergency calls are received and triaged by dispatchers who

coordinate with healthcare facilities to ensure appropriate response and transportation of patients (6).

EMS personnel are trained to provide initial medical care and stabilization at the scene of an emergency. They communicate with hospitals and primary care centers to determine the most suitable destination for patients based on their condition and the available resources at different healthcare facilities (26).

When a patient is transported to a hospital, there is a structured handover process to ensure continuity of care. EMS providers communicate important patient information to hospital staff, including vital signs, medical interventions performed, and any pre-hospital treatments administered. This facilitates a smooth transition of care from the pre-hospital setting to the hospital environment (27).

EMS providers in Germany often follow collaborative care protocols established in coordination with hospitals and primary care centers. These protocols outline specific treatment guidelines, medication administration, and procedures to be followed in various emergency situations. This helps ensure standardized care and seamless integration between EMS and other healthcare providers.

After an emergency, EMS providers may provide feedback and information to hospitals and primary care centers about the patient's condition upon arrival at the hospital. This feedback loop enables healthcare providers to evaluate the effectiveness of pre-hospital care, make necessary adjustments to protocols, and improve patient outcomes (28).

These examples highlight the interconnectedness between EMS, hospitals, and primary care centers in Germany, emphasizing the collaborative approach to patient care throughout the healthcare system. The integration aims to optimize resources, improve patient outcomes, and provide timely and appropriate care during emergencies.

3.3.2. Integration of EMS and other facilities in Croatia

The integration of EMS with other healthcare providers in Croatia involves close collaboration and coordination to ensure a seamless continuum of care for patients. When EMS personnel respond to an emergency, they assess the patient's condition, provide initial medical treatment, and determine the appropriate level of care needed. Depending on the situation, they may transport the patient to the nearest appropriate healthcare facility, such as a hospital or clinic.

Once the patient arrives at the healthcare facility, the EMS personnel communicate relevant information to the receiving healthcare professionals, including the patient's condition, vital signs, and any treatments administered. This exchange of information helps the healthcare providers prepare for the patient's arrival and continue the necessary medical interventions.

In Croatia, hospitals and other healthcare providers work closely with EMS to ensure efficient and effective emergency medical care. They collaborate in terms of treatment protocols, patient transfers, and sharing of medical records and information. This integration aims to optimize patient outcomes by facilitating timely and coordinated care.

It's worth noting that the specific protocols and integration processes may vary between regions or healthcare facilities within Croatia. Local healthcare systems and policies can influence the level of integration between EMS and other providers.

8.4. Legal and regulatory frameworks

3.4.1. Legal and regulatory frameworks in Germany

Germany has emergency medical services acts at the state (ger. *Bundesland*) level, which define the legal framework for prehospital emergency care. These acts regulate the organization, responsibilities, and quality standards of emergency medical services within each state (16).

The Federal Social Security Code in Germany, particularly Book V (SGB V), governs statutory health insurance and covers aspects of prehospital emergency care financing, reimbursement, and patient rights.

The German Medical Association plays a significant role in shaping the regulatory framework for prehospital emergency care. It develops guidelines and standards for medical practice, including emergency medical services.

Each German state has its own regulations and guidelines that further define the organization and operation of prehospital emergency medical care services within their jurisdiction. These regulations often include requirements for personnel certification, ambulance equipment, and emergency response protocols.

DIN EN 1789 European standard, issued in Germany by the German Institute for Standardization (DIN), specifies requirements for ambulances and their equipment, including design, safety features, and medical equipment. It ensures that ambulances used in EMS operations adhere to certain quality and safety standards.

3.4.2. Legal and regulatory frameworks in Croatia

The Health Act (cro. *Zakon o zdravstvenoj zaštiti*) in Croatia establishes the legal framework for healthcare services, including prehospital emergency medical care. It defines the rights and responsibilities of patients, healthcare providers, and health insurance organizations.

Croatia has a specific act Emergency Medical Services Act (cro. *Zakon o hitnoj medicinskoj službi*) that governs the organization and functioning of emergency medical services. It outlines the requirements for ambulance services, training and certification of emergency medical personnel, emergency call systems, and coordination between various stakeholders.

Prehospital emergency medical care is organized and regulated at the county level in Croatia. Each county has its own regulations that specify the standards, protocols, and guidelines for emergency medical services within their jurisdiction.

The Croatian Institute for Emergency Medicine (HZHM, cro. *Hrvatski zavod za hitnu medicine*) is the central institution responsible for managing and coordinating emergency medical services

in Croatia. It establishes guidelines, conducts research, and provides training for emergency medical personnel.

8.5. Emergency Dispatch and Communication Systems

8.5.1. Dispatch Systems

Both Croatia and Germany prioritize timely response and coordination in their emergency dispatch systems. However, specific operational details, infrastructure, and technologies may vary between regions within each country.

8.5.1.1. Dispatch Systems in Germany

In Germany, emergency calls are directed to the nationwide emergency number 112. Calls are received by regional control centers operated by the local authorities with paramedics as dispatchers. Often the control centers are part of the fire departments. These control centers are responsible for triaging the calls and dispatching the appropriate resources (6).

The control center dispatchers gather information from callers and assess the urgency and severity of the situation using standardized protocols. They determine the appropriate response level and allocate resources accordingly. This may involve dispatching ambulances, fire services, or other specialized emergency units (29).

In Germany, Integrated Dispatch Centers (IDCs) are responsible for coordinating emergency responses. These centers bring together representatives from different emergency services, such as EMS, fire service, and civil protection to ensure effective collaboration and resource allocation (30).

Computer-Aided Dispatch Systems (CAD) systems are widely used in Germany's emergency dispatch process. These systems enable efficient communication, resource tracking, and coordination between the PSAPs, IDCs, and responding units. They facilitate the exchange of

critical information, such as location data, incident details, and status updates, to enhance the coordination of care.

8.5.1.2.Dispatch Systems in Croatia

In Croatia, emergency calls are typically handled by the Integrated Emergency Medical System (IMSI) centers, known as cro. "*Hitna pomoć* 112." These centers serve as the primary point of contact for individuals reporting emergencies. Calls made to the universal emergency number 112 are received by trained operators who gather essential information from callers. The number 194 is a direct contact to the EMS and works in emergency situations as good as 112 (31).

Based on the information obtained during the emergency call, the call center operators perform triage to assess the severity of the situation. They determine the appropriate level of response required and allocate resources accordingly. This can involve dispatching ambulances, medical teams, or other emergency services.

Once the appropriate response has been determined, the IMSI center coordinates with local EMS units and communicates the details of the emergency to them. This coordination ensures that the nearest available resources are dispatched promptly to the scene.

8.5.2. Technologies and communication systems

While Germany and Croatia share some similarities in the technologies and communication systems used for emergency medical communication, specific implementations and infrastructures may vary. Both countries prioritize efficient communication, real-time information exchange, and coordination to enhance emergency response and patient care.

3.5.2.1. Technologies and communication systems in Germany

Germany utilizes Computer-Aided Dispatch (CAD) systems to enhance emergency medical communication. These systems facilitate efficient call intake, resource allocation, and tracking of emergency units. They provide real-time information to operators and support the coordination of emergency response (32). The Central Bed Management and Control Office is responsible for coordinating and managing hospital bed capacities in Germany. Its task is to maintain an overview of available bed capacities in hospitals and provide this information to the control centers of the emergency medical services. The collaboration between the Central Bed Management and Control Office and the control centers enables efficient and needs-based management of the emergency medical services. When an emergency call is received, the control centers can use the information from the Central Bed Management and Control Office to determine which hospitals in the vicinity have available bed capacities. This allows them to organize the transportation of patients directly to hospitals with available beds and avoid bottlenecks (33,34).

Germany employs integrated communication networks that enable seamless communication between emergency call centers, dispatch centers, and field units. These networks utilize digital radio systems, such as TETRA (Terrestrial Trunked Radio), which allow for secure and reliable voice communication among emergency personnel (35).

Ambulances in Germany are often equipped with mobile data terminals (MDTs) that enable real-time communication between dispatch centers and EMS personnel. MDTs facilitate the exchange of critical information, such as patient data, location details, and updates on the situation, to enhance coordination and decision-making (36).

Geographical Information Systems (GIS) technology is widely used in Germany for emergency medical communication. It enables accurate mapping, routing, and navigation, allowing dispatchers to determine the most efficient routes for emergency units. GIS also provides valuable information about nearby medical facilities and resources (37).

3.5.2.2. Technologies and communication systems in Croatia

Croatia operates the Integrated Emergency Medical System (IMSI), which includes emergency call centers and a network of ambulance services. The IMSI system integrates telecommunication technologies and dispatch systems to facilitate emergency medical communication (38,39).

Similar to Germany, ambulances in Croatia are often equipped with mobile data terminals (MDTs). These MDTs enable real-time communication between the call center and EMS personnel, facilitating the exchange of vital information, updates, and coordination during emergency response.

Croatia utilizes telecommunications infrastructure, including digital radio systems and telecommunication networks, to support emergency medical communication. These systems ensure reliable and secure communication between emergency services and healthcare providers.

8.6.Training and education

3.6.1. Training and education in Germany

In Germany, the primary level of prehospital emergency care is provided by Emergency Medical Technicians (EMTs), known as ger. "*Rettungssanitäter*." EMT training programs typically last around 3 months and cover topics such as anatomy, physiology, emergency procedures, patient assessment, and basic life support. Training programs include both classroom instruction and practical clinical training (40).

Germany also has a higher level of prehospital emergency care provided by Paramedics, known as ger. "*Notfallsanitäter*." To become a Paramedic, individuals must complete a 2 to 3-year training program. The curriculum includes advanced medical knowledge, skills in advanced life

support, administering medications, and managing complex medical emergencies. Paramedic training includes clinical rotations in hospitals and ambulance services (19).

The training to become an emergency physician (ger. *Notarzt*) in Germany is rigorous and requires extensive medical knowledge as well as practical experience in emergency medicine.

To become an emergency physician, doctors undergo residency training in a relevant medical specialty, often in Anesthesiology, Internal Medicine, or Surgery. This residency training typically lasts several years and includes theoretical education as well as practical experience in emergency medicine.

In addition to the specialty residency, doctors pursue specialized training in emergency medicine. This training, often referred to as ger. "*Zusatz-Weiterbildung Notfallmedizin*," lasts around two years. During this period, doctors gain practical experience in emergency medical services, emergency departments, or intensive care units (41).

An essential component of becoming an emergency physician is completing a specific emergency physician course. This course includes theoretical instruction and practical exercises to provide doctors with the necessary knowledge and skills in prehospital emergency care. The course also entails successful participation in practical examinations and simulations.

Upon completing the training and successfully passing the course, physicians are granted the designation of ger. "*Notarzt*." This title allows them to work as emergency physicians in the emergency medical services and perform advanced medical procedures during emergency missions. Ongoing professional development and continuing education are required to maintain the competence and quality of emergency care.

Germany also has specialized training for Emergency Medical Dispatchers, known as ger. "*Leitstellendisponenten*." Dispatchers undergo training programs that focus on emergency call handling, triage, and coordinating appropriate responses. They receive training in communication techniques, resource allocation, and decision-making (29).

EMTs, Paramedics, and Emergency Medical Dispatchers in Germany are required to participate in regular continuing education to keep their skills and knowledge up to date. Continuing education programs cover topics such as new treatment guidelines, emerging technologies, and advancements in emergency medical care (42).

3.6.2. Training and education in Croatia

In Croatia, the primary level of prehospital emergency care is provided by Emergency Medical Technicians (EMTs), known as cro. "*medicinski tehničari*." To become an EMT, individuals must complete a 2-year vocational training program at a medical school. The curriculum includes theoretical and practical training in emergency medical procedures, patient assessment, basic life support, and ambulance operations (43).

Croatia also has a higher level of prehospital emergency care provided by Paramedics, known as cro. "*medicinski tehničari – smjer specijalističke medicinske sestre/tehničara hitne medicine*." To become a Paramedic, individuals must first complete the EMT training program. Afterward, they can pursue additional specialized training, typically a 1-year program, to become Paramedics. Paramedics have advanced skills and knowledge in areas such as advanced life support, administering medications, and managing complex emergencies (44).

Depending on the severity and nature of the emergency, an emergency physician or cro. "*liječnik hitne medicine*" may be dispatched to the scene or accompany the patient during transport. Emergency physicians underwent a 4-year residency program in emergency medicine and can provide advanced medical interventions and making critical decisions in time-sensitive situations. In some regions, the doctor is always part of the ambulance crew, so that a doctor is present on every call. In many cases, however, these doctors are rather junior doctors in their first years of training than specialists in emergency medicine.

Both EMTs and Paramedics are required to participate in regular continuing education programs to maintain their certification. These programs focus on updates in emergency medical care, new procedures, protocols, and advancements in the field (45).

8.7. Role of academic institutions, training centers and continuing education programs

3.7.1. Role of academic institutions, training centers and continuing education programs in Germany

In Germany, academic institutions such as universities and medical schools play a significant role in the education and training of EMS personnel. They offer training programs for Emergency Medical Technicians (EMTs) and Paramedics, providing comprehensive theoretical and practical education. These institutions contribute to the professional development and academic advancement of EMS personnel (42).

Training centers and academies in Germany specialize in providing practical training and skill development for EMS personnel. These centers offer hands-on training using simulation equipment, patient scenarios, and real-life simulations. They focus on enhancing technical skills, decision-making abilities, and teamwork (46).

Continuing education is highly valued in Germany to ensure ongoing professional development of EMS personnel. Various organizations, including professional associations and training centers, offer continuing education programs. These programs cover a wide range of topics, including new treatment protocols, advancements in technology, leadership skills, and specialized procedures. They provide opportunities for EMS personnel to update their knowledge, stay current with best practices, and expand their competencies (47).

3.7.2. Role of academic institutions, training centers and continuing education programs in Croatia

In Croatia, academic institutions similar to Germany, play a crucial role in the education and training of EMS personnel. They offer vocational training programs for Emergency Medical Technicians (EMTs) and specialized training programs for Paramedics. These institutions provide the necessary theoretical knowledge and practical skills to prepare individuals for their roles in prehospital emergency care.

Training centers in Croatia, often affiliated with academic institutions or healthcare organizations, provide practical hands-on training for EMS personnel. These centers offer simulation-based training, skills workshops, and scenario-based exercises to enhance clinical competencies and decision-making abilities.

Continuing education is an essential component for maintaining and advancing the knowledge and skills of EMS personnel in Croatia. Various organizations and institutions provide continuing education programs, including workshops, conferences, and online courses. These programs offer updates on new procedures, technologies, and best practices in emergency medical care.

The role of academic institutions, training centers, and continuing education programs in both Croatia and Germany is crucial for ensuring high-quality training, professional growth, and the ongoing development of EMS personnel. These entities contribute to the standardization of education, the acquisition of essential skills, and the dissemination of knowledge within the field of prehospital emergency care. They also serve as platforms for research, innovation, and collaboration among healthcare professionals and academia.

8.8. Equipment and resources

3.8.1. Availability of equipment

3.8.1.1. Availability of equipment in Germany

There is generally a high availability of medical equipment for prehospital emergency care in Germany. Ambulances are equipped with a range of essential medical equipment, including cardiac monitors, defibrillators, airway management devices, intravenous supplies, and immobilization equipment. Advanced life support equipment, such as ventilators and infusion pumps, may also be available on certain ambulance units (20).

Germany has a fleet of well-maintained and appropriately equipped ambulances. The availability of ambulances is generally sufficient to meet the demand for prehospital emergency care services. Additionally, Germany has specialized vehicles for specific situations, such as mobile intensive care units (MICUs) for critical care transport (48).

3.8.1.2. Availability of equipment in Croatia

The availability of medical equipment in prehospital emergency care in Croatia may vary depending on the region and resource allocation. Ambulances are typically equipped with basic medical equipment, including devices for patient assessment, basic life support, and immobilization. However, the availability and standardization of advanced medical equipment may be limited in some areas.

Croatia has a fleet of ambulances to provide prehospital emergency care services. However, the availability and standardization of vehicles can vary across different regions. In some areas, there may be challenges in terms of fleet size, vehicle maintenance, and availability of specialized vehicles for specific situations.

3.8.2. Standardization of medical equipment

3.8.2.1. Standardization of medical equipment in Germany

The medical equipment used in prehospital emergency care in Germany is generally standardized. The equipment meets national and international standards (EN 1789) and is

regularly inspected for functionality and compliance. Standardization ensures that EMS providers across the country have access to consistent and reliable equipment (20).

Ambulances in Germany are designed and built to meet specific standards and regulations. There are guidelines and regulations in place to ensure the standardization of vehicle features, equipment layout, safety measures, and infection control protocols. This standardization helps promote consistency and interoperability among EMS units (20).

3.8.2.2. Standardization of medical equipment in Croatia

The standardization of medical equipment in prehospital emergency care in Croatia may vary depending on the region and resource availability. While efforts are made to ensure basic standards, there may be variations in the types and quality of equipment used in different areas (49,50).

In Croatia, there may be variations in the standardization of ambulance vehicles. While there are regulations and guidelines in place (50), the standardization of vehicles can be influenced by factors such as regional resources, budget constraints, and procurement processes. This can result in variations in vehicle specifications and features across different areas (51).

8.9. Performance measures and outcomes

3.9.1. Performance measures

3.9.1.1. Performance measures in Germany

Response time is a commonly used performance measure in Germany to evaluate prehospital emergency medical care. The goal is to ensure that EMS units reach the scene promptly after receiving an emergency call. Monitoring response times helps assess the efficiency and accessibility of emergency medical services. The national average response time for EMS units

is typically around 8-12 minutes, although this can vary based on the location and urban/rural divide (22).

Patient outcomes, such as survival rates and functional outcomes, are important indicators used to evaluate the effectiveness of prehospital emergency medical care in Germany. These indicators provide insights into the impact of interventions and the overall quality of care on patient health and well-being (52).

Clinical performance measures evaluate specific aspects of care delivery, including adherence to clinical guidelines, use of evidence-based practices, and appropriate interventions. These measures assess the clinical quality of care provided by EMS personnel and help identify areas for improvement and standardization (52).

Documentation and reporting measures focus on the accuracy and completeness of patient records and incident reporting. Proper documentation ensures the capture of essential information, facilitates continuity of care, and supports quality improvement efforts.

3.9.1.2. Performance measures in Croatia

Like Germany, the response time is used as a common performance measure to evaluate the effectiveness of prehospital emergency medical care in Croatia. Response time is monitored and assessed to ensure timely access to emergency care. In Croatia, response times for EMS units may vary depending on factors such as geographical location, population density, and infrastructure. The average response time can range from 10-15 minutes or longer, especially in remote or rural areas (53,54).

Patient outcomes are important outcome indicators used to evaluate the quality of prehospital emergency medical care in Croatia. These indicators include measures such as survival rates, patient satisfaction, and functional outcomes. Tracking patient outcomes provides insights into the effectiveness of interventions and the overall quality of care provided by EMS personnel (52).

Process measures assess the adherence to established protocols and guidelines during prehospital emergency care. These measures include factors such as appropriate assessment and management of patients, use of standardized protocols, proper administration of medications, and adherence to safety practices. Process measures help evaluate the consistency and quality of care provided by EMS personnel (52).

3.9.2. Patient Outcomes and Mortality Rates

3.9.2.1. Patient Outcomes and Mortality Rates in Germany

The German healthcare system, including prehospital emergency care, generally demonstrates favorable patient outcomes. The system's emphasis on high-quality care, well-trained personnel, and advanced medical interventions contributes to positive patient outcomes. Mortality rates for certain conditions, such as cardiac arrest, have shown improvements due to early access to care, prompt resuscitation, and coordinated hospital services (55).

3.9.2.2. Patient Outcomes and Mortality Rates in Croatia

Patient outcomes and mortality rates in prehospital emergency care in Croatia may vary depending on several factors. The country has made efforts to improve the quality of emergency medical care, but outcomes are be influenced by factors such as response times, availability of specialized interventions, and access to advanced hospital care (54). Mortality rates and patient outcomes is also influenced by the underlying health status of the population and the specific nature of the emergency cases encountered.

In addition to response times and patient outcomes, other relevant metrics may include the rate of bystander CPR (Cardiopulmonary Resuscitation), the utilization of advanced medical interventions (such as defibrillation or advanced airway management), hospital transfer times,

and the rate of prehospital deaths. These metrics can provide insights into the effectiveness, efficiency, and quality of prehospital emergency medical care (55–57).

8.10. Challenges and future directions

3.10.1. Challenges and barriers

8.10.1.1. Challenges and barriers in Germany

Germany, like many countries, faces the challenge of an aging population and increasing demand for prehospital emergency care services. The growing demand can put strain on resources and may lead to longer response times (58).

Germany's urban-rural divide can impact access to emergency medical care services, particularly in rural or remote areas. Limited healthcare infrastructure and longer travel distances can result in delayed response times and potentially affect patient outcomes.

Ensuring seamless communication and coordination among various healthcare entities, including EMS, hospitals, and dispatch centers, can be a challenge. Interoperability of systems and effective information sharing are crucial for efficient patient transfers and continuity of care.

Germany, like many countries, faces shortages of trained emergency medical personnel. There is a need to recruit and retain an adequate number of qualified professionals to meet the growing demand for prehospital emergency care services (59).

Incorporating and integrating evolving technologies, such as telemedicine, electronic health records, and advanced communication systems, into prehospital emergency care can be a challenge. Ensuring smooth adoption and utilization of these technologies requires investment, training, and infrastructure support.

8.10.1.2. Challenges and barriers in Croatia

Croatia's diverse geography, including remote and rural areas, can pose challenges in terms of access to emergency care. Transporting patients quickly and efficiently to healthcare facilities in these areas can be challenging due to limited infrastructure and long distances (53,54).

Ensuring equitable distribution of resources, including ambulances, medical equipment, and personnel, across different regions can be a challenge. Some areas may face resource shortages, leading to longer response times and potentially affecting the quality of care.

Adequate funding for prehospital emergency medical care services can be a challenge in Croatia. Limited financial resources may impact the availability of advanced equipment, training opportunities, and staffing levels (24).

Recruiting and retaining an adequate number of trained emergency medical personnel, including paramedics and emergency medical technicians, can be a challenge. The availability of qualified staff in all regions of Croatia may be limited, particularly in rural areas.

Efforts are being made in both countries to address these challenges through policy initiatives, resource allocation, training programs, and infrastructure development.

3.10.2. Future directions

3.10.2.1. Future directions in Germany

Germany has been implementing integrated care models that aim to improve coordination and collaboration among different healthcare providers, including emergency medical services, hospitals, and primary care physicians. These models focus on seamless transitions of care, enhanced communication, and shared decision-making to optimize patient outcomes.

In 2013 the *Notfallsanitätergesetz* (NotSanG), a law regulating the competences in EMS in Germany, was introduced to enhance the competence of emergency medical services and to consequently relieve the need for emergency doctors. It standardizes training, establishes the

profession of ger. "*Notfallsanitäter*" (paramedics), and expands their skills and competences. The law promotes collaboration with other healthcare professions and aims to improve patient safety and the quality of emergency care, especially in rural areas with low density of physicians (19).

In Germany, some cities have tested the system of mobile stroke units in pilot projects. They are equipped with specialized diagnostic equipment and personnel. These units can rapidly diagnose and initiate treatment for stroke patients at the scene, reducing the time to treatment and improving patient outcomes (60).

Germany has been actively promoting digitalization in healthcare, including emergency medical care. Efforts are underway to enhance the exchange of information and data sharing between EMS providers, hospitals, and other healthcare stakeholders. This facilitates real-time information transfer, streamlined workflows, and improved coordination of care.

In recent years, telemedicine has gained importance in Germany, particularly in the area of rural healthcare where sufficient medical infrastructure is not always available. Telemedicine enables doctors to assess patients remotely, provide medical advice, and perform certain treatments. The legal framework and political support for telemedicine have improved in Germany. Clear legal guidelines now exist for telemedical consultations, data protection, and reimbursement of telemedical services. Additionally, the COVID-19 pandemic has increased interest in and the necessity of telemedicine, as it ensures medical care even during times of contact restrictions and quarantine (61–63).

Germany emphasizes the ongoing professional development of EMS personnel. Continuing education programs, training courses, and certification requirements are in place to ensure that EMS providers stay up-to-date with the latest advancements and best practices in prehospital emergency care.

3.10.2.2. Future directions in Croatia

Croatia has implemented a National Emergency Medical Service Development Program aimed at improving the quality and accessibility of emergency medical care. The program focuses on enhancing the education and training of emergency medical personnel, improving the infrastructure and equipment, and optimizing the coordination between emergency medical services and hospitals (64).

Croatia has established a Helicopter Emergency Medical Service (HEMS) to provide rapid access to medical care in remote or hard-to-reach areas. The HEMS units consist of helicopters equipped with medical personnel and equipment, allowing for faster response and transport of critically ill or injured patients to appropriate healthcare facilities (54).

Establishment of an emergency maritime medical service on high-speed vessels is underway to establish an emergency maritime medical service using high-speed vessels, connecting Croatia's islands with the coastal area. The service will provide effective emergency care, utilizing six equipped vessels for medical assistance, search and rescue, and response to maritime accidents and disasters. Dispensaries at initial destinations will perform medical tests to determine the need for emergency transport, reducing costs (53).

Croatia is increasingly utilizing telemedicine in prehospital emergency care. Telemedicine allows real-time communication between EMS personnel in the field and medical experts in hospital settings, enabling remote consultations, support, and guidance for complex cases. This technology helps improve decision-making, enhance triage processes, and optimize patient care (65).

These initiatives, reforms, and innovations are aimed at improving the quality, efficiency, and accessibility of emergency medical care delivery in both Croatia and Germany. They reflect the ongoing commitment to enhancing prehospital emergency care services and optimizing patient outcomes.

4. Discussion

When comparing the organization of prehospital emergency medical care in Croatia and Germany, several key similarities and differences emerge. Both countries have established well-structured systems aimed at providing timely and effective emergency medical care to their populations. However, they differ in certain aspects due to variations in healthcare systems, geographical factors, and resource allocation.

In terms of legislative and regulatory frameworks, both Croatia and Germany have robust systems in place to govern prehospital emergency medical care. They have defined standards, protocols, and guidelines to ensure the quality and safety of care provided by EMS personnel. The role of academic institutions, training centers, and continuing education programs is crucial in both countries to train and certify EMS providers.

Technologies and communication systems play a vital role in enhancing emergency medical communication. Germany demonstrates a higher utilization of advanced technologies, such as computer-aided dispatch (CAD) systems and telemedicine, which facilitate efficient resource allocation and decision-making. Croatia, while also adopting these technologies, may face challenges in implementing them uniformly across the country.

The availability and sophistication of equipment and resources may differ between the two countries. Germany generally has a higher number of specialized resources, such as mobile intensive care units (MICUs), physician-staffed response units, and air medical services. Croatia's resources may vary depending on the region, with some areas having limited access to advanced equipment and specialized resources, particularly in remote and rural areas, which can impact response times and the overall quality of care.

Training and education requirements for EMS providers are well-established in both countries. They have defined curricula, certification processes, and ongoing professional development opportunities to ensure the competency and continuous learning of EMS personnel. However,

Germany demonstrates a more comprehensive approach to continuing education and professional development. In Croatia, emergency medical technicians (EMTs) receive training through a 12-month educational program, while paramedics undergo a 24-month program. In Germany, the introduction of the ger. "*Notfallsanitätergesetz*" (NotSanG) has established the profession of ger. "*Notfallsanitäter*" (paramedic) requiring a three-year training program with more comprehensive skills and knowledge, that enables the EMS-teams to carry out advanced medical measures without a doctor on site and thus to compensate for the falling density of emergency doctors.

The education and training of ger. *Notärzte* in Germany and emergency physicians in Croatia differ in terms of duration, requirements, and specialization.

In Germany, ger. Notärzte undergo a comprehensive training pathway beginning with a medical degree, followed by residency training in a relevant specialty. After completing the specialty residency, physicians pursue additional training in emergency medicine through a two-year specialized program. This includes theoretical education, practical experience in emergency medical services, and successful completion of an emergency physician course. The training equips them with the knowledge and skills to perform advanced medical procedures in prehospital emergency care.

In Croatia, the training to become an emergency physician is organized differently. After completing a medical degree, doctors enter a five- to six-year residency program in Emergency Medicine. This program focuses specifically on emergency care and provides comprehensive training in various aspects of the specialty. The program includes rotations in emergency departments, intensive care units, and other relevant areas, allowing physicians to gain practical experience in managing a wide range of emergency cases. Due to the shortage of staff in the EMS, in many cases young residents fulfill the part of the emergency physicians, which may not always result in the optimal care for patients in emergency situations.

To address the challenges and barriers in prehospital emergency medical care, both countries have implemented various initiatives and reforms. Croatia has focused on improving infrastructure, education, and technology adoption, while Germany emphasizes integrated care models, mobile stroke or intensive care units, digitalization, and data sharing.

Regarding the integration with Healthcare System, Germany has a strong integration between prehospital and in-hospital care. The EMS works closely with hospitals, allowing for seamless patient handover and coordinated care. Croatia is also moving towards improved integration between prehospital and hospital care, but the level of integration may vary between regions.

It's important to mention that these differences may not encompass the entirety of the systems in each country, as both Croatia and Germany have complex and evolving EMS systems.

5. Conclusion

In conclusion, this thesis has explored and compared the organization of prehospital emergency medical care in Croatia and Germany. Through an in-depth analysis of the systems' structures, response models, training and qualifications, equipment and resources, and integration with the healthcare system, several key differences have been identified.

While each country faces its unique set of challenges, it is evident that both Croatia and Germany are committed to continuously improving their prehospital emergency medical care systems. They recognize the importance of timely access to care, well-trained personnel, advanced technologies, and coordination among different healthcare stakeholders to ensure the best possible outcomes for patients.

Croatia's decentralized model with county-level EMS systems contrasts with Germany's more centralized approach with state-level coordination centers.

Training and qualifications vary, with Croatia offering 12-month and 24-month programs for EMTs and paramedics, respectively, while Germany has implemented a comprehensive three-

year training program for paramedics. There are also major differences regarding the education and organization of emergency physicians in both countries. The systems in place both show weaknesses and strengths but focus the possibilities and needs of the respective population.

Differences in equipment and resources were observed, with Germany generally having more specialized resources, such as MICUs and physician-staffed units. Integration with the healthcare system is well-established in Germany, while Croatia is progressively improving integration between prehospital and in-hospital care.

The findings of this thesis highlight the diverse approaches to prehospital emergency medical care in Croatia and Germany, reflecting the influence of cultural, organizational, and healthcare system factors. These differences have important implications for service delivery, quality of care, and patient outcomes in each country.

Further research and collaboration between the two countries can facilitate knowledge exchange and identification of best practices, fostering continuous improvement in prehospital emergency medical care. By understanding and appreciating the strengths and challenges of each system, policymakers, healthcare professionals, and stakeholders can work towards optimizing the organization of prehospital emergency medical care in both Croatia and Germany, ultimately enhancing patient care and outcomes.

6. Summary

The comparison of prehospital emergency medical care organization in Croatia and Germany reveals notable differences. Croatia employs a decentralized model with county-level EMS systems, while Germany adopts a more centralized approach with state-level coordination centers. Response models differ, with Croatia utilizing a tiered system and Germany employing a dual-response model. Training durations and qualifications vary, with Croatia offering shorter programs for EMTs and paramedics compared to Germany's comprehensive three-year

paramedic training. Equipment and resource disparities exist, with Germany having more specialized resources. Integration with the healthcare system is more established in Germany, but Croatia started initiatives to modernize their system. Understanding these differences is crucial for optimizing prehospital emergency medical care in each country, enhancing service delivery, quality of care, and patient outcomes. Continued research and collaboration can facilitate the exchange of knowledge and best practices, fostering improvements in both systems.

Key words: Croatia, health care system, Germany, prehospital emergency care

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8. Curriculum vitae

Alexander Fritzen was born in 1993 in Cologne, Germany and grew up in Münster, Germany, where he graduated from high school in 2013. After his school career, he decided to complete a federal voluntary service with an aid organization in the rescue service. The experiences and impressions he was able to gain during this period were decisive for his further professional career. In 2014, Alexander began training as an emergency medical technician at a rescue service school in Münster and expanded this training in 2015 in Düsseldorf, Germany, where he obtained the professional title of "paramedic". This was followed by 2 years in which he worked as an employee of the city of Ratingen in the emergency rescue service of the Ratingen fire brigade. In October 2017 he was admitted to study medicine at the University of Rijeka, Croatia. During the summer breaks he did several internships in hospitals throughout Germany

(Traumatology and Orthopedics, Internal Medicine, Pulmonology, Dermatology) and is expected to graduate at the university of Rijeka as a medical doctor in October 2023.