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CONTENT

LEADERSHIP IN SURGICAL CLINICS IN THE LIGHT OF SYSTEMS APPROACH AND CONTINGENCY THEORY: HARMONIOUS MANAGEMENT AND FLEXIBLE LEADERSHIP PERSPECTIVES

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1. INTRODUCTION

This study aims to examine the use of systems and contingency theories in the management of surgical clinics. It focuses on how these theories can guide surgical clinical leadership and how effective management can be achieved.

The healthcare industry operates in a complex and rapidly changing environment. Surgical clinics are places where effective leadership skills are important as well as technical competencies. The importance of this study focuses on understanding how systems and contingency theories can influence and guide leaders in the management of surgical clinics.

Management of surgical clinics includes a combination of patient safety, staff coordination, technology integration and ethical standards. This complexity can make it difficult to effectively manage the needs of multidisciplinary teams, patients, and environmental factors. The aim of this study is to understand

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how systems and contingency theories can be applied to surgical clinical leadership and management.

The study was created using the compilation method. Information from the available literature is analyzed, focusing on systems and contingency theories, to examine how leadership can be enhanced in surgical clinical management.

In the literature, it is seen that systems and contingency theories have received wide attention in the fields of health sector and leadership. However, more research is needed on how these theories apply and the value they provide in the context of surgical clinical management and leadership.

This study examines how systems and contingency theories can be used to provide effective leadership in surgical clinical management. While systems theory provides guidance in understanding the complexity of surgical clinics and coordinating interactions between components, contingency theory emphasizes the importance of leadership being in tune with environmental conditions and situation. This work can help surgical clinical leaders to lead appropriately to patients' needs, changing circumstances, and clinical needs.

The healthcare industry has a complex and dynamic environment and operates under constantly changing conditions. In this context, surgical clinics are one of the places where both technical skills and effective management are critical. The management of surgical clinics covers not only medical processes, but also a wide spectrum including patient safety, staff coordination, ethical standards and more (Budakoğlu, 2015).

In this study, we will focus on how basic management theories such as systems theory and contingency theory can be applied in surgical clinical management. While systems theory treats organizations as complex and interactive systems, contingency theory emphasizes that the leadership approach

should be compatible with the environmental conditions and leadership situation. These two theories provide us with a comprehensive perspective in understanding how leadership should be shaped in surgical clinical management.

The management of surgical clinics is a process that requires the provision of specialized medical services. However, this process involves a number of dynamic factors that include not only medical competencies, but also teams from different specialties, technology, patients' needs and changing health policies. In this context, systems theory can help us understand how surgical clinics can handle this complexity and how each component is interconnected (Karakaya & Daşlı, 2021). On the other hand, contingency theory states that leadership is a job that requires flexibility and adaptability. In surgical clinics, leaders must accurately assess what kind of leadership approach is required at a given time and situation and adjust their leadership style accordingly. In addition, environmental factors such as the needs of patients, health policies and technological developments are also important factors that shape the leadership approach (Korkmazer, 2021). This study examines how leadership in surgical clinical management can be approached from the perspective of systems and contingency theories. In the following sections, we will explore how systems theory applies and provides insight into surgical clinical management. Next, the impact of contingency theory on surgical clinical leadership will be evaluated. Evaluations of how these theories can provide guidance for the effective management and leadership of surgical clinics will provide important information for the development of the health sector and improving the quality of patient services.

2. DIFFERENCES BETWEEN SURGICAL CLINICAL LEADERSHIP AND BUSINESS LEADERSHIP

Leadership in surgical clinical management may differ from general business and business leadership. The differences between both areas can be:

Technical Expertise and Special Requirements: When leading surgical clinics, leaders often must understand the specific requirements of the healthcare industry and the technical aspects of surgical practice. Professionals working in such clinics have specific areas of expertise and needs, so it is important for leaders to understand and manage these areas of expertise (Özkan, 2021).

Risk and Ethical Issues: Surgical procedures and healthcare are often high risk and involve ethical issues. Therefore, surgical clinic leaders have to pay special attention to issues such as patient safety, medical ethical standards and legal requirements (Çitak & Kahraman, 2021).

Patient Communication: Leadership in the healthcare industry includes direct communication with patients. Surgical clinic leaders must have the ability to communicate well with patients. It is important to understand the needs of patients and to satisfactorily inform them.

Healthcare Regulations: The healthcare industry is often subject to strict regulations. Surgical clinic leaders should have knowledge of medical licenses, health care regulations and hospital management standards (Dizili & Öztürk, 2021).

Team Dynamics: Teams working in surgical clinics consist of individuals with different specialties such as doctors, nurses, surgical technicians and administrative staff. Therefore,

surgical clinical leaders must have the ability to effectively manage people from different specialties (Dellinger et al., 2016).

General leadership principles and skills apply in both areas, but healthcare industry leadership is shaped by taking into account the specific needs and ethical challenges of the industry, especially in surgical clinics.

3. REQUIRED QUALITIES OF SURGICAL CLINIC LEADERS

Qualifications required for surgical clinical leaders encompass both the specific requirements of the healthcare industry and general leadership qualities. Here are some key traits that surgical clinical leaders should have:

Medical Knowledge and Expertise: Surgical clinic leaders must understand the specifics of the healthcare industry and be familiar with the technical aspects of surgical practice. This is important so that patients can properly guide their treatment and care (Souba,2004).

Communication Skills: Surgical clinic leaders must be able to communicate effectively with patients, healthcare professionals, and other administrative staff. Good communication is the foundation for building patient trust, collaborating and guiding teams effectively.

Problem Solving Ability: In the health sector, especially in surgical clinics, unexpected situations and emergencies may arise. Leaders must have the ability to think quickly and solve problems effectively.

Business Ethics and Ethics: Surgical clinic leaders must comply with patient confidentiality, treatment ethics, medical standards, and legal regulations. Having business ethics and ethical values increases the credibility of leaders.

Motivation and People Management: Leaders should be able to motivate employees, evaluate their performance, and offer development opportunities. It is important to effectively manage personnel from different specialties in surgical clinics.

Decision-Making Ability: Surgical clinic leaders should be able to make quick and informed decisions. These decisions must be made to maximize the health and safety of patients.

Adapting to Change: The healthcare industry is constantly evolving and changing. Leaders must have the ability to follow new technologies, treatments, and regulations.

Stress Management: Surgical clinic leaders must be able to cope with intense and stressful situations. It is important to stay calm and make effective decisions, even under stress.

Innovation and Development Focus: Leaders must be open to develop the clinic and offer innovative solutions. They should encourage improvement in order to consistently achieve better results.

Collaboration and Teamwork: In surgical clinics, teams from different specialties work together. Leaders must have the ability to collaborate and bring together different expertise (Ravikumar & Parks 2020).

These features are essential for successful management by surgical clinic leaders. Although it overlaps with general leadership qualities,it has been shaped by taking into account the special needs of the health sector.

4. APPROPRIATE TYPES OF LEADERSHIP FOR SURGICAL CLINICAL LEADERSHIP

Appropriate leadership types for surgical clinical leadership should be selected taking into account the specific

needs of the healthcare industry and the functioning of surgical clinics. Here are some of the leadership types that may be appropriate for surgical clinical leadership:

Transformational Leadership: Transformational leaders motivate team members by providing vision and inspiration. In the healthcare industry, transformational leadership can mobilize members of the surgical team to achieve better outcomes and foster continuous improvement (Goleman et al., 2002). Service-Oriented Leadership: These types of leaders focus on the needs of patients and healthcare recipients. Surgical clinic leaders can adopt a service-oriented leadership approach to maximize patient satisfaction and build patient confidence (Money et al. 2014).

Participatory Leadership: It is a leadership style that involves the surgical team members more in the process. This can be used to evaluate the different expertise and views of healthcare professionals and to come up with solutions.

Situational Leadership: Situational leaders can adjust their leadership styles to suit each situation and the abilities of team members. Surgical clinical leaders can adapt their leadership approach according to different surgical procedures or disease states.

Educational and Developmental Leadership: Surgical clinic leaders can offer training and development opportunities so teams can continually improve. This leadership style can be used to improve clinical outcomes by developing specialties (Uğur, 2010).

Ethics and Values-Oriented Leadership: Ethical issues are common in the healthcare industry. Therefore, surgical clinic leaders can lead by respecting ethical values and patient rights.

Innovation and Technology-Driven Leadership: Surgical clinics should be open to technology and innovations. By

adopting new medical technologies, leaders can improve surgical procedures and increase patient outcomes.

Collaboration and Team-Oriented Leadership: It is important that teams from different specialties in surgical clinics collaborate. Leaders can create an effective collaboration environment by bringing team members together.

Which leadership style is most appropriate may vary depending on factors such as the clinical makeup, characteristics of the team, and goals of the organization. The ideal leadership style should be chosen in accordance with the needs of the surgical clinic and the strengths of the leader.

5. TYPES OF LEADERSHIP UNSUITABLE FOR THE SURGICAL CLINIC

Certain types of leadership may not be appropriate for surgical clinical leadership, given the characteristics of the healthcare industry and the requirements of surgical clinics. Here are some types of leadership to consider in this context:

Authoritarian (Autocratic) Leadership: Authoritarian leaders usually take decisions alone and lead in a command-and-command fashion. In the healthcare sector, an authoritarian leadership style may not be appropriate because of the need to value the opinions of patients and professionals (Denmark, 1977).

Laissez-Faire Leadership: Laissez-faire leaders often give team members too much freedom and minimize direction. This leadership style may not be compatible with the sensitive and rapid decision-making requirements in surgical clinics (Wilson et al. 2004).

Democratic Leadership (Participatory Leadership): A fully democratic leadership style can also make it difficult to find quick solutions to problems. While it may be necessary to make

quick and precise decisions in surgical clinics, waiting for the opinions of team members on every issue can sometimes cause a waste of time (Fleishman,1953).

Transactional Leadership: This type of leadership encourages performance using rewards and punishments. Since patient safety and ethical behavior of health professionals are at the forefront in the health sector, a leadership approach governed by rewards and punishments may not be appropriate.

Narcissistic Leadership: Narcissistic leaders often put their self-interest and ego satisfaction first. This type of leadership can lead to problems with sensitive issues such as patient safety and ethical issues.

Hierarchical Leadership: An overly hierarchical leadership style can inhibit open communication and collaboration. In surgical clinics, this type of leadership can be challenging when the different expertise of team members must come together and make quick decisions.

Whether a leadership style is effective or not may vary depending on factors such as clinical structure, team characteristics, and the leader's skills. The most appropriate leadership style should be determined by considering the needs of the surgical clinic and the goals of keeping the health professionals and patient safety at the highest level.

6. CRITICAL ISSUES FOR LEADERS IN SURGICAL CLINICS

There are many issues that are critical to leaders in surgical clinics. These issues are important for both clinical management and patient safety. Here are some topics that may be critical to leaders in surgical clinics:

Patient Safety: Leaders should give utmost importance to the safety and health of patients and take all necessary precautions in this regard. Protocols should be established and followed to minimize medical errors and complications.

Medical Ethics and Compliance: The healthcare industry is an area where ethical standards are maintained at a high level. Leaders must comply with medical ethics, respect patient privacy and rights, and comply with all legal requirements (Primrose,2019).

Team Collaboration and Coordination: Surgical teams consist of professionals from different specialties. Leaders should ensure that these teams work in harmony, strengthen communication and support the cooperation environment (Aydemir & Yildirim, 2016).

Staff Management: Nurses, surgical technicians, doctors, and other staff play an important role in the running of the clinic. Leaders must manage staff, evaluate their performance, and offer training opportunities as needed.

Compliance with Hospital and Regulatory Standards: Surgical clinics must adhere to certain healthcare standards and regulations. Leaders should ensure that these standards are followed and focus on succeeding in audits.

Equipment and Technology Management: Surgical procedures may require special equipment and technologies. Leaders must maintain and update this equipment, adapt to new technologies and optimize the workflow.

Risk Management and Emergency Plans: Surgical clinics may experience unexpected situations and emergencies. Leaders must identify risks, take preventive measures, and create contingency plans.

Patient Communication and Patient Satisfaction: Leaders should be able to communicate effectively with patients, understand patients' needs, and strive to maximize patient satisfaction (Collins- Nakai,2006).

Training and Development: The healthcare industry is constantly evolving. Leaders should support the continuing education and development of clinical staff and enable them to learn new treatment methods and technologies.

Financial Management: The financial health of surgical clinics is important. Leaders must be knowledgeable about budget management, income and expense analysis, and manage the clinic in a financially sustainable way.

These issues are critical for surgical clinical leaders to manage successfully and effectively. Each issue can have an impact on patients' health, patient safety, and clinical performance.

7. DEVELOPING INSIDER LEADERS IN SURGICAL CLINIC MANAGEMENT

It is very important for leaders to train inside leaders in surgical clinical management. Growing inside leaders means identifying, developing and supporting the leadership potential of existing team members and employees. This approach can be beneficial for ensuring continuity within the clinic, maintaining institutional knowledge and experience, increasing employee motivation and improving the quality of healthcare services.

The advantages of the insider leader cultivation approach in surgical clinical management may be:

Maintaining Clinical Culture: Insider leaders understand the clinic's culture and values better and can be more effective at maintaining that culture.

Institutional Knowledge and Experience Transfer: Insider leaders have an in-depth knowledge of the clinic's operation, patients' needs, and procedures. Transferring this knowledge and experience to new leaders can improve clinical performance.

Increased Motivation and Engagement: Employees can be motivated by seeing that their team members have the potential to rise as leaders. This can increase employee engagement and performance.

Shorter Adaptation Period: Insiders can adapt more quickly to new leadership positions as they will already know the workings and dynamics of the clinic.

Customized Development Opportunities: Better understanding of the strengths and weaknesses of insider leaders. This can help create personalized leadership development plans.

Better Collaboration and Communication: Insider leaders can engage more closely with employees. This can increase communication, encourage collaboration,and place greater value on employee views.

However, raising an insider leader can also have some challenges. For example, if current employees are promoted to leadership positions, they may have difficulty establishing authority over their former friends or peers. With such challenges in mind, internal leader training programs should be well planned and supported.

8. LEADERSHIP IN SURGICAL CLINIC MANAGEMENT ACCORDING TO SYSTEMS THEORY

Systems theory considers organizations and management as a system and examines the interaction of the components of these systems. If we consider surgical clinic management in the

context of systems theory, we can evaluate the concept of leadership and the functioning of surgical clinics as follows:

Balance of means and ends: Systems theory says that organizations are shaped by both means (functions, structures) and ends (goals, results). Leadership in surgical clinics should serve the purposes of treatment and care of patients while optimizing the functioning of the clinic.

Interaction of Components: It is a system consisting of different components such as surgical clinics, doctors, nurses, surgical technicians, administrative staff. Leadership must coordinate the interaction of these different components and ensure that they work in harmony.

Feedback Loops: Systems theory emphasizes that feedback loops help organizations continually improve. Surgical clinic leaders can continually improve clinical operation by collecting patient feedback and employee insights.

Integrity and Connections: Surgical clinics are holistic systems that include different departments and functions. Leaders must understand these connections and evaluate how each component within the clinic interacts with the others.

Dynamic and Variability: The healthcare industry has a constantly changing environment. Leaders must understand the dynamic nature of systems, be able to adapt quickly and respond to changing conditions.

Achievement of Goals and Optimization: Systems theory states that organizations must be optimized to achieve goals and achieve the best results. Surgical clinical leaders must be tasked with optimizing systems to maximize patient outcomes and quality of treatment.

Interaction with the External Environment: Surgical clinics interact with external environmental components such as

patients, hospital management, medical suppliers, regulatory agencies. Leaders must have the ability to adapt and cooperate with the external environment.

Innovation and Innovation: Systems theory states that organizations should encourage innovation and innovation. Surgical clinical leaders must support innovation to integrate new treatment methods and technologies, foster continuous improvement, and achieve better outcomes for patients.

Surgical clinical leadership plays a role in understanding, guiding and optimizing all components of the system. Systems theory can use leadership as a framework for understanding the complexity and interaction of the organization.

9. LEADERSHIP IN SURGICAL CLINIC MANAGEMENT ACCORDING TO CONTINGENCY THEORY

Contingency theory emphasizes that leadership approach and style should be compatible with environmental factors and leadership situation. If we consider surgical clinical management in the context of contingency theory, it is important that the leadership approach is compatible with the environmental conditions and leadership situation. Here are some points to consider about leadership in surgical clinical management based on this theory:

Role of Situational Factors: Surgical clinics are influenced by a variety of factors, including different patient situations, procedures, and team components. Leaders must understand these situational factors and adjust their leadership approach accordingly.

Leadership Status and Needs: Leadership situations determine what type of leadership approach is needed at a given

time and situation. Surgical clinic leaders must choose appropriate leadership styles for different situations, such as emergencies, complex surgical procedures, or patient satisfaction.

Impact of Environmental Conditions: Environmental conditions around surgical clinics can affect leadership style. For example, factors such as changes in health policies, the development of medical technologies or competitive conditions can affect how leadership is shaped.

Team Dynamics: Surgical clinics consist of teams from different specialties. Leaders must understand the dynamics of these teams, assess the skill levels of their team members, and adapt their leadership style accordingly.

Changing Situations and Adaptation: Leaders in surgical clinical management must be able to adapt quickly to suddenly changing situations. Flexibly adjusting your leadership style to new and unexpected situations can affect the success of the clinic.

Patient Needs and Satisfaction: Contingency theory states that the leadership approach should be aligned with patient needs and satisfaction. Surgical clinical leaders should adopt a patient-oriented leadership style and focus on taking the necessary steps for the safety and satisfaction of patients (Künzle et al., 2010).

Communication and Cooperation: Communication and cooperation are important in surgical clinics. Leaders should ensure effective communication among team members and promote a harmonious collaborative environment.

Contingency theory emphasizes the importance of leaders adapting to changing circumstances, rather than a "one size fits all" approach to leadership. Leadership in surgical clinics can be more successful when applied flexibly and effectively, taking into account situational differences and changing needs.

10. CONCLUSION

The intricate world of surgical clinical management demands a nuanced understanding of leadership, one that encompasses the complexities of the healthcare environment and the adaptability to navigate its ever-changing dynamics. In this realm, systems theory and contingency theory emerge as invaluable guiding frameworks, offering a holistic lens to comprehend and effectively manage the intricacies of surgical clinics.

Systems theory sheds light on surgical clinics as intricate ecosystems, where diverse teams from various specialties, technological advancements, and patient needs intertwine to form a seamless whole. This perspective underscores the importance of recognizing interconnectedness, fostering harmonious collaboration among these elements, and ensuring that each component functions in synergy to deliver optimal patient care.

Contingency theory complements these systems view by emphasizing the adaptability of leadership styles to suit the specific context and demands of the surgical setting. Surgical clinical leaders must be adept at assessing the environmental conditions, patient needs, health policies, and technological developments that shape their leadership landscape. By adopting a flexible approach, they can tailor their strategies to match the unique challenges and opportunities presented by their circumstances.

The interplay of systems theory and contingency theory empowers surgical clinical leaders to navigate the complexities of their domain and achieve the overarching goals of patient-centered care, staff harmony, and enhanced healthcare quality. Systems theory provides a framework for understanding the interconnectedness of the surgical clinic ecosystem, while

contingency theory highlights the need for adaptable leadership styles to address the dynamic environment.

Effective leadership in surgical clinical management is not merely about managing tasks and procedures; it is about cultivating a culture of collaboration, innovation, and continuous improvement. By embracing the insights of systems theory and contingency theory, surgical clinical leaders can foster a thriving environment where patients receive exceptional care, staff feel valued and empowered, and the quality of healthcare services consistently elevates.

As the healthcare industry continues to evolve, the role of leadership in surgical clinical management becomes increasingly pivotal. Equipped with the understanding provided by systems and contingency theories, surgical clinical leaders can navigate the ever-changing landscape, ensuring that their leadership practices remain effective, ethical, and aligned with the ultimate goal of providing the highest standards of patient care.

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TECHNOLOGICAL DEVELOPMENTS IN SURGICAL NURSING EDUCATION: OBJECTIVELY STRUCTURED CLINICAL EXAMS

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1. INTRODUCTION

Learning consists of internalizing knowledge, observing and applying. Nurses are expected to be equipped with knowledge, skills and competence in dealing with different cases and in complex healthcare fields. At this point, nursing education focuses on training qualified nurses (Guerrero et al., 2023:766; Vasli et al., 2021).

In nursing education and in the evaluation of students' clinical competencies, knowledge must be transformed into experience and integrated. Traditional training generally includes one-way methods with limited feedback. In addition, traditional education has negative effects such as lack of standardization, inconsistency, bias, instructor focus, poor reliability, lack of focus on real knowledge, and inability to evaluate various skills. Additionally, assessing students' clinical competencies is among the important challenges faced by nursing educators. On the other hand, in the last 20 years, innovative methods such as simulation,

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role-play, scenario and case analysis, multimedia and mind mapping have become widespread in nursing education. Among these innovative methods, Objective Structured Clinical Exams have been developed to evaluate students objectively and standardized (Fawaz and Alsalamah, 2021; Gad, 2016: 124; Kassabry, 2023).

2. OBJECTIVELY STRUCTURED CLINICAL EXAMS

Objective Structured Clinical Examinations (OSCE) are planned and structured exams designed based on simulations and scenarios to evaluate students' clinical skills. Using a standard checklist and scoring tool in evaluating students provides "objectivity"; having a similar scenario and scoring tool with the same difficulty for each student, testing a skill at each station is "structured"; “clinical” in that each skill represents actual clinical settings and practices; testing each nursing skill with a standardized tool in terms of knowledge, skills and attitude defines an "exam" (Bdair et al., 2019: 271).

In OSCE, the suitability of students' clinical skills is evaluated at stations with simulation and case-based scenarios that imitate real life. OSCE consists of many stations created according to factors such as the number of students and educators, the difficulty level and quality of clinical skills. It usually consists of 10-20 stations and each station is given 5-20 minutes. While a large number of stations limits the applicability of OSCE, a small number may negatively affect the application of necessary skills and determination of students' proficiency (Bdair et al., 2019: 271). Students perform their nursing skills under the supervision of a different instructor at each station and complete each station by progressing through the stages (Fawaz and Alsalamah, 2021).

OSCE preparation and planning process, determining the skills to be evaluated and the number of stations; deciding on the time required for each skill at the stations; creation of skills assessment guides, scoring checklists and case scenarios; providing training to trainers and standardized patients; providing sufficient tools, equipment, materials, and appropriate physical space; creation of stations; determination of station flow and sequence cycle; consists of the preparation and training of students (Bdair et al., 2019:271).

In the OSCE application, students enter the stations created at regular intervals and in a sequence when the bell rings and perform the skill in the station at a predefined time. With each bell tone, it is announced that the time is up and the student moves on to the next station. At the end of OSCE, each student passes all stations and is evaluated according to a standard scoring system (Vasli et al., 2021; Ali et al., 2012: 60).

With OSCE, students' basic nursing skills and knowledge in terms of cognitive, emotional and psychomotor, communication skills with patients and team members, and patient evaluation competencies are determined (Fawaz and Alsalamah, 2021; Ha and Lim, 2023:11).

OSCE advantages include easy implementation; having high validity and reliability; unbiased and objective evaluation; can be adapted to the subject as a flexible and structured exam; experiencing life-like clinical skills; comprehensive and fair assessment of skills for each student at the same station and scoring system; be risk-free in terms of patient safety and legal liability; provides an opportunity for learning and evaluation. In addition, with OSCE, students' skills and attitudes such as communication and professionalism, which are difficult to evaluate with traditional methods, can be evaluated, their active participation in the learning process is ensured, their critical

thinking and logical reasoning skills develop, and their self-confidence and motivation increase (Bdair et al., 2019: 271; Ali et al., 2012: 60; Yuan, 2021:160; Tseng et al., 2021: 2).

The disadvantages of OSCE include its high cost; need for constant and complex planning and organization; large number of students; the need for a large number of educators and observers; Providing intensive training to observers and educators about testing, evaluation and scoring; case scenarios and checklists take a long time to score; difficulty in keeping stations confidential; weakening of the holistic approach due to stations focusing on specific nursing skills and competencies; creates anxiety and stress for students (Bdair et al., 2019: 271).

3. SURGICAL NURSING EDUCATION AND OBJECTIVELY STRUCTURED CLINICAL EXAMS

Basic clinical skills training constitutes a large part of nursing education in training competent and qualified nurses to improve, maintain and protect public health (Darban et al., 2019: 1). Nursing education, which is generally planned to last 4 years in the world, covers many courses, especially in internal and surgical fields (Tseng et al., 2021: 2). Surgical Diseases Nursing course, which is among these courses, focuses on patient care before, during and after surgery, and also provides clinical practice training in operating rooms of health institutions, ambulatory surgery units and other areas where surgical intervention is performed. Surgical clinics and operating rooms differ from other units because they are complex and stressful areas where acute and emergency situations are managed, the diversity of procedures and practices, the high workload and responsibility, the necessity of quick and clear decision-making (Yazdimoghaddam et al., 2021: 2; Nayyeri et al., 2021: 2).

Nursing care is a dynamic process. Clinical decision making and competencies of nurses in patient care are among their most important skills. In the Surgical Diseases Nursing course, nursing competencies develop as students can experience knowledge and skills, evaluate patients holistically with their physical-mental-spiritual and sociocultural dimensions, and correctly apply clinical practices in nursing care. Clinical practice, knowledge and skills can be evaluated with OSCE, which is a modern type of exam that evaluates the development of students. When the studies in the literature are examined, it is seen that the OSCE method is becoming increasingly widespread in the Surgical Diseases Nursing Course. In addition, it is seen that this method is also used in post-graduate training of surgical nurses (Gad, 2016: 124; Tseng et al., 2022: 1).

Sawhney et al. (2018) conducted a study evaluating the feasibility and effectiveness of simulation training given to nurses on the evaluation and management of patients in epidural analgesia. This study included standardized patients and used workshop evaluation before and after training. Standardized patients were provided with training on case scenarios relevant to this study. For standardized patients to resemble real patients, they were required to wear a patient gown, lie in bed, have an intravenous catheter in their hand, tape the epidural catheter to the back area, and ensure the connection of the catheter to the analgesic medication, have a patient identification wristband, and create files containing information about the patient's health status. This study includes training nurses with a 4-hour workshop developed within the framework of best practices by a team of faculty members and clinical experts. In the first stage, nurses filled out demographic characteristics and epidural analgesia knowledge level questionnaires. Then, a single-station OSCE, which included a standardized patient assessment of epidural analgesia, was completed by nurses.The OSCE was led

by a specialist nurse in the surgical clinic. In the second stage, nurses were given 1 hour of theoretical and practical training on the care, management and evaluation of patients in epidural analgesia. Then, small group practice was carried out by nurses on epidural analgesia case scenarios. After the training, single-station OSCE, demographic characteristics and epidural analgesia knowledge level surveys were completed. An information session was held at the end of the workshop to clarify accurate and safe information in the care of patients receiving epidural analgesia and to receive feedback. OSCE was created from introduction (explanation of procedure, hand washing, physician order, analgesia pump setting, vital signs, pain), sensory evaluation, motor evaluation, equipment evaluation, and critical thinking. As a result of the study, it was determined that there was a significant increase in the nurses' knowledge levels compared to before the workshop. In the OSCE evaluation, it was determined that there was a significant increase in the correct skills performed in all sections except equipment evaluation. It has been reported that nurses' confidence in the care of patients receiving epidural analgesia has increased. Additionally, positive feedback was given about the training being conducted with standardized patients (Sawhney et al., 2018: 248).

Unal and Ozdemir (2023) conducted a randomized controlled study to examine the effect of burn care training given using the hybrid simulation method on the knowledge, skills and empathy levels of nursing students. Burn care competencies and skills were assessed by OSCE. The content validity of the OSCE form was examined by faculty members and clinical nurses. OSCE form consists of two categories: OSCE-1 and OSCE-2. The OSCE-1 category consists of 10 steps for the physical evaluation of burns, and each step is scored as successful or unsuccessful. OSCE-2 category consists of 4 steps as burn intervention and 7 steps as referral criteria evaluation, for a total

of 11 steps. Each student was given 7 minutes to complete the OSCE. Students in both groups were given general information about the physiology, formation and types of burns within one class hour. Then, training was provided for four class hours using case studies on first, second, third and fourth degree burns and visual films containing knowledge, skills and holistic care. Following the training, the pre-test burn care information form, OSCE and empathy scale were completed. Hybrid simulation was applied to the patients in the experimental group. In the hybrid simulation, the case scenario included standardized patients with a wearable burn model. In this scenario, a diabetic patient who developed second-degree burns on left chest area and left leg due to hot water was imagined. Three weeks after the application, the burn care information form, OSCE and empathy scale were administered to the students in both groups as posttests to evaluate their knowledge, competence and empathy skills. As a result of the study, while there was no difference in the knowledge levels of the students in both groups before the application, the knowledge level of the students in the experimental group was found to be significantly higher after the application. The students in the experimental group were found to have significantly higher burn physical evaluation skills, burn care practices and evaluation of referral criteria. In addition, the empathy scores of the students in the experimental group were determined to be significantly higher compared to the control group (Unal and Ozdemir, 2023).

Hosseini et al. (2023) conducted a study evaluating the effect of a virtual game developed on students in the operating room in recognizing surgical instruments and setting up surgical sets. The developed game consists of two parts. The first part included the most commonly used surgical instruments in 6 branch surgeries: cardiovascular, gastrointestinal, thorax, ear, nose and throat (ENT), neurology and orthopedics. When each surgical instrument is selected, information about the name of the

surgical instrument and its intended use is displayed. In the second part of the game, an appropriate box was created on the sterile material table for each surgical instrument. During the game, each surgical instrument must be placed in the appropriate box, and points are scored when placed in the correct position. In case of incorrect placement, the surgical instrument returns to its place in the game menu. There are 3 tables consisting of surgical sets for each surgery in the game. The study consisted of 3 groups. While the first group was taught cardiovascular, gastroenterology and thoracic surgery sets by game method; ENT, neurology and orthopedics sets were taught using the traditional method. While the second group was taught cardiovascular, gastroenterology and thoracic surgery sets with the traditional method; ENT, neurology and orthopedics sets were taught using the game method. The third group is the control group and surgical set training for 6 branches was given only with the traditional method. Before the application, a pre-test on surgical instruments and sets was performed in all three groups. In the study, as a traditional education method, a theoretical lesson was given on the names and usage areas of surgical instruments for 2 hours a week for 30 days. Each group was evaluated with OSCE 1 week, 2 weeks and 3 months after completing the planned applications. An area similar to the OSCE operating room environment was created and planned as 6 different stations for each surgical skill. OSCE is scored as knowing surgical sets, setting up surgical instruments, and learning the use of each instrument. When the study findings were examined, no difference was found in the pre-test scores of the students in the three groups regarding surgical instruments and sets. When the OSCE results 1 week and 2 weeks after the application were compared, the skill scores of the students who received game-based education were found to be significantly higher than those of the students who received traditional education. While there was no significant difference in skill scores in the group receiving game-based training in the OSCE

results 2 weeks and 3 months after the application; a significant decrease was determined in the group receiving education with the traditional method. In addition, when the OSCE results were compared, a gradual decrease was detected in the scores of the group receiving education with the traditional method. This may indicate that knowledge is more permanent with game-based education (Hosseini et al., 2023: 4).

Akbari et al. (2022) conducted a similar study comparing game-based training and virtual training for students' knowledge and skills of basic surgical instrument setups in the operating room. Students in both groups were given theoretical lessons for 16 weeks and 2 hours per week. In order to measure the knowledge, a pre-test was applied to the students who participated in the study and their knowledge levels were measured. Four weeks after the theoretical lessons, an additional session on basic surgical instruments and their setup was given to the virtual training group on an online platform. Additionally, students were provided with access to a book and video about surgical instruments and their setup for 1 week. They were asked to apply individual homework and self-assessment tests on the subject. A video was sent to the game-based training group after the theoretical training to teach them how to play the game, and the students were asked to log in to the game individually whenever they wanted for 1 week. Both groups were informed to contact the researchers via message when needed. One week after the application, as a final test, the student's knowledge levels and surgical instrument setup skills were evaluated with the OSCE, which was created as a single station. With OSCE, each student was evaluated based on time, score, errors and bonuses within 7 minutes. Time is considered as the remaining time to complete the installation. The score was obtained by scoring retractors, hemostats, graspers, cutters, dissectors, needle holders, and others in the surgical instrument classification tool. Error indicated the

number of errors made in correct positioning of surgical instruments. Bonus is defined as the correct positioning of all surgical instruments in a classification.When the students' knowledge levels before the application were compared, no significant difference was found between the two groups. When the knowledge levels were compared after the application, it was seen that there was a significant increase in both groups. This increase was found to be significantly higher in the group receiving game-based education than in the group receiving virtual education. When OSCE results were compared, students in the game group completed surgical instrument setup in a shorter time than the virtual training group. In addition, while the score and bonus numbers were significantly higher in the game-based group compared to the virtual training group, a significant result was obtained in terms of fewer errors (Akbari et al., 2022: 5).

4. CONCLUSION

OSCE is one of the assessment methods increasingly used in nursing education. The use of OSCE methods in the Surgical Diseases Nursing course can make a positive contribution to the knowledge and skills of students. Additionally, the development of nursing competencies can be supported with this method. With OSCE, students' empathy skills, satisfaction, self-confidence, motivation and permanence of knowledge can be increased.

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NANOTECHNOLOGY AND HEALTH

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1. INTRODUCTION

Nanotechnology, which has a great development potential, provides significant advances and benefits in the field of health by providing the production of more suitable devices for drug development, gene transfer, treatment, prevention of diseases and traumatic wounds, and protection of human health and taking precautions [1, 2].

Nanotechnology has effectively entered the field of drug delivery [3]. Drug delivery systems include nanoparticles, carbon nanotubes, fullerenes, nanogels, and dendrimers [4, 5]. Improvements are constantly being made to maximize the performance of smart drug delivery systems and minimize undesirable side effects. Studies have been increasing in recent years to highlight the basic requirements for the development of new nanotechnology-based drug delivery systems [6]. Chung et al. conducted research on increasing the tumor targeting efficiency of PLGA nanoparticles. They found that the retention of these PLGA nanoparticles on tumor cells was higher [7]. Nafee et al. By determining the properties of PLGA nanoparticles as a result of morphological analyzes performed with a scanning probe microscope, they increased the retention on lung cancer cell lines [8].

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Tumor tissues are detected and marked with magnetic iron oxide nanoparticles, and special antibodies developed against this tumor are given to the body. The labeled antibodies adhere to the tumor surface, and the tumor is detected by the MRI device thanks to these collected iron oxides. In this way, even the smallest tumor can be detected [9].

The field of nanovaccines has been advancing rapidly in recent years, thanks to the increase in nanotechnology devices and more knowledge about polymeric drug delivery. These vaccines contain synthetic polymer nanoparticles that contain tumor proteins that the body's immune system can recognize. This vaccine is important in the fight against cancer that people will self-administer [10].

In addition, cleaning of wounds on the body from microbes can be achieved with silver nanoparticles. Some nanoparticles are used to cure infections. Examples of these are wound creams containing nanoparticles embedded with nitric oxide gas. When these creams are applied to the wound, these nano particles release the nitric oxide gas they contain, causing the bacteria to die [11].

One of the subjects studied in recent years is textiles produced with nanotechnology. Research has been done on protective textiles and nanotechnology, information has been given about smart textiles using sensors, and studies in the field of defense have been exemplified [12].

One of the emergence points of quantum technology is actually nanotechnology. Since many nanomaterials also exhibit quantum properties, significant advances have been made in quantum technology. Quantum calculations were also affected by this situation and became another research field that made great progress.

The technology uses quantum information at the nanoscale to continue the calculation. With the support of nanotechnology and nanoscale memories and information resources, the usability of information has also been increased. The ability to make inferences from this information precedes machine learning, also known as artificial intelligence. When analyzing data, correct decisions can be made independently by machines.

Artificial intelligence, which accompanies robotics, has also slowly begun to move from factories to human-oriented applications. For example, autonomous driving systems that combine sensing, inference, control and operation features are a product of this.

Internet of Things (IoT) or "Industrial Internet of Things (IIoT)", which is one of the areas that have attracted attention in recent years, continues to grow with the development of accurate data recording and automated data analysis methods, while IoT, one of the areas affected by nanotechnology, will continue to grow as nanotechnology applications develop. It can also speed up.

Using nanomaterials as sensing tools in IoT sensors can help obtain more accurate data thanks to their high sensing properties. Many properties of nanomaterials, such as being able to measure optical changes from a long distance, assimilating atoms on the surface, being able to stretch, stretch and compress, are beneficial at this point [13]. With the increasing use of nanosensors and nanomachines that communicate with each other and share data over the internet, the concept of IoT has evolved and revealed the "Internet of Nano Things (IoNT)" [14]. Investments made by governments, especially in the aerospace and defense sectors, are accelerating the anticipated development of the IoT market. While studies on important technological

devices such as nanodrones are gaining importance, it is thought that in the future, these devices will be able to make observations and carry explosives strong enough to penetrate the target.

IoT systems also create significant impacts in the healthcare sector. Nanomedicines produced with nanotechnology, nanomachines and sensors connected to IoNT provide great support to the processes of preventing, diagnosing and treating diseases [15].

Biochips powered by nanotechnology allow early diagnosis of cancer or viral diseases that may occur in the body. Nanomaterials are also beneficial in reducing the likelihood of body rejection of organ transplants, artificial bone applications, and other medical implants [16].

Nanomaterials produced with nanotechnology are used in almost every sector. It is now possible to encounter nanomaterials in products produced in all areas of life, from biomedical products to electronics, from the defense industry to the health industry, from clothing to the energy industry and even the food industry [17-20].

Besides the positive effects of nanotechnology, there are also great risks it brings. Artificial intelligence, robotics, autonomy, and emerging machines and products raise some important questions. It is therefore important to examine the good or bad possibilities that may arise in the future due to nanotechnology, and to investigate where these situations come from and what they may lead to. Interventions using nanotechnology in natural processes attract attention with their possible great risks. For example, the CRISPR (Clustered Regularly Interspaced Palindromic Repeats) method, which is a gene editing method that uses an enzyme and guide RNA to rearrange genes, is used to correct gene errors that occur in nature with nanotechnology [21].

However, along with the benefits of this method, there are also huge risks. Unnoticeable future cell deterioration or affecting healthy genes in large-scale DNA changes is considered a serious risk. When these mistakes are applied to a person without being noticed, it is possible that serious illnesses may occur. Scientists recommend that the use of CRISPR for gene therapy should be approached very carefully and its possible harmful effects should be investigated in detail [22].

It is also possible to reduce these possible major risks with the right work. Novo Nordisk Basic Protein Research Center scientists are working to detect undesirable side effects of gene editing methods such as CRISPR and ensure that they do not reoccur. With the help of a cryoelectron microscope, how the enzyme used in the process is examined closely at the nanoscale, how it does its job, and any errors it may cause are detected. Later, the CRISPR method can be improved to prevent errors from being repeated. It is thought that this research may enable more precise and error-free gene therapies in the future [23].

As the use of nanotechnology increases worldwide, the nanomaterials we are exposed to in our daily lives are also rapidly increasing. The possible damages and toxic effects of nanomaterials on biological ecosystems and humans continue to be investigated. Toxic properties of nanomaterials may vary depending on the natural environment, particle size, shape, subcomponents and coating [24].

It is thought that nanomaterials may pose serious risks to human health in some areas. “Ultra-small” particles used in diesel engines and power plants have the potential to cause serious damage to the lungs with the metals and hydrocarbons they carry. Nanomaterials, which can enter the body through the skin or digestive system, have the potential to cause damage to DNA and cells with the free radicals they create. In addition, their ability to

cross the brain-blood barrier if transported through the blood circulation system also raises concern.

Finally, while the human body can tolerate naturally occurring elements and molecules, when it encounters new components for which natural immunity does not occur, it may perceive them as toxic and try to take precautions. It can harm the body due to overactivity of the immune system.

The information obtained about the toxic effects of nano products on the environment remains quite limited [25-27]. Although there are partial studies on toxic effects and evidence that nanoparticles may have harmful effects on human health, there are also many uncertainties on this subject. In addition to its many advantages, nanotechnology also brings risks and uncertainties for human health [28-30]. For example, silver nanoparticles provide odor control in clothes and disappear when washed. If materials with antibacterial properties, such as silver, accumulate excessively, they cause damage [31].

The large surface areas of nanoparticles provide surfaces to which toxic chemical pollutants can bind and be transported. It is stated that the ability of nanoparticles to enter the body and cells may cause toxic substances to spread within the body, and as a result, cell and tissue damage and disorders in the defense mechanism may ocur [28]. Nanotechnology laboratory waste is mostly carried to water, then to soil through water, and from there to our food. Nanoparticles can be inhaled, through food and drink, or even through the skin. It comes and enters our body [32].

Nano-sized particles have a toxic effect on cells. At the same time, nanoparticles taken into the body easily pass into the blood. It has the possibility of affecting many organs in the body [33]. The target area affected by inhalation of nanoparticles is usually the lungs. Nanomaterials have been proven to cause body responses to irritation, injury, or infection. However, the factors

that determine the severity of reactions are not fully understood. In this context; In case of gene transfer, enzyme change and local changes on surfaces with nanotechnology; The risk will be above controllable levels.

Metal nanoparticles used in the field of health can also cause cell poisoning in humans. In most studies, it has been determined that DNA damage increases with increasing nanoparticle concentration [34]. Metal nanoparticles Since they are small in size, they can directly enter the cell and nucleus and lead to the formation of free radicals in the cell. It can also cause genetic damage by binding to DNA.

In an experiment, nano titanium dioxide was applied under the skin of pregnant mice and it was observed that it was transferred to the offspring. As a result of monitoring the offspring, it was determined that there was brain damage and reproductive problems in the male offspring. Brain damage was also observed in fish exposed to nanoparticles for 48 hours. These structures are created by cells It has been shown that intake can also enter the food chain through bacteria.

For example, mercury in fish and hormones in meat may pose health threats. Titanium dioxide nanoparticles, which caused brain damage when used in mice, are also used in sunscreens. Research has shown that nanoparticles also have harmful effects on the nervous system [35].

2. CONCLUSION

In order to obtain information about the toxic effects of nanoparticles, the retention and accumulation of nanoparticles in living systems and cells must be well known. For this reason, natural effects covering different doses and exposure times can be observed on different species of organisms.

It is also very important to conduct studies [36]. Since the studies in this field are limited, it is thought that this article is important to examine the beneficial and harmful effects of nanotechnology on human health. The more widespread use of nanotechnology in the future will mean that people will come into greater contact with nanoparticles. For this reason, nanoparticles may affect human health, especially the respiratory system, and the environment. Its possible negative effects need to be further investigated [27].

Nanotechnology, a multidisciplinary field that encompasses a variety of devices derived from engineering, physics, chemistry and biology, has an increasing role in our society. Nanotechnology, energy and environment, construction, engineering, transportation, telecommunications and medicine In addition to being the beginning of a new era with their use, they change people's lifestyles [37]. Although there are few studies conducted using synthesis, silver, gold, platinum and zirconium nanoparticles are frequently encountered in synthesis [26, 38].

Nanoparticles produced by various synthesis methods. It is affected by the starting solution, concentration, temperature and operating frequency. Accordingly, exposure times increase and its effects on human health become greater [30]. For example, microorganisms that cause many diseases.

Silver nanoparticles, which are known to destroy silver nanoparticles, are obtained by using herbal extracts through biosynthesis and when used in surface sterilization of parts taken from some plants, they create a toxic effect and prevent growth and development [39].

Nanoparticles interact closely with the environment, the most affected being humans and plants, which are essential components of the entire ecosystem. The toxic effects of nanoparticles on humans and the environment cannot be fully

determined, and the reactions of these creatures to nanoparticles are also uncertain. It cannot be determined precisely [40, 41].

While the health risks that nanomaterials produced with nanotechnology may pose in the future continue to be investigated, the abundance of unknowns raises concerns. One of the biggest disadvantages the world faces due to nanotechnology is the lack of employment in traditional agriculture, manufacturing and industry due to the great development in nanotechnology. Technology, when used wisely and for the good of society, makes a unique contribution to nature.

When we look at the developments in the field of nanotechnology from a broad perspective, it is possible to say that it affects dozens of different fields. However, despite the opportunities and developments that nanotechnology offers to the world, it should not be forgotten that it also has potential risks. Advances in this field, which lie at the basis of today's and future technologies, will be an important step for humanity to move towards new horizons.

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THE IMPORTANCE OF ISOKINETIC SYSTEMS IN PHYSIOTHERAPY AND REHABILITATION

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Uğur SÖZLÜ[2]

1. INTRODUCTION

Rehabilitation aims to reach the former strength and power capacity of the individual as soon as possible after the injury. Isokinetic exercises have been used frequently in recent years to improve muscle strength and are considered to be the most effective method (Sahin, 2010). The isokinetic dynamometer provides an assessment of dynamic muscle strength and overall function by measuring the joint moment applied during constant joint angular velocity movements. It has widespread applications in the measurement of muscle strength in sports, exercise and pathological conditions, evaluation of training or rehabilitation programs, performance prediction, injury prevention and basic research on the mechanics of muscles, tendons and joints, modeling and simulation, and many other related fields (Akaras, 2021).

Isokinetic dynamometers are extremely useful and unique devices that allow the assessment of dynamic muscle and joint function under specific conditions. The isokinetic

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dynamometer is considered a reliable and valid device for assessing muscle strength and is often used as the gold standard for other strength assessments (Stark, Walker, Phillips, Fejer, & Beck, 2011). An isokinetic dynamometer allows to assess muscle function with a compliant resistance at a constant angular velocity, thus enabling maximal force production over a prescribed range of motion (NEH) (Habets, Staal, Tijssen, & van Cingel, 2018a; Perrin, 1994). During isokinetic contraction, contraction occurs with constant velocity throughout normal joint motion and has equal and maximal resistance throughout the entire movement.

Assessment of muscle and joint function in sport and exercise is essential not only for performance purposes but also for injury assessment and rehabilitation. The isokinetic dynamometer is one of the safest forms of exercise and testing. When the preset angular velocity is reached, the moment of resistance equals the net moment applied, so that the joints and muscles are loaded to maximum capacity over a constant (isokinetic) range of motion. Since the dynamometer moment of resistance does not exceed the net moment normally applied, there is no joint or muscle overload and therefore no risk of injury (Payton & Burden, 2017). The way it is performed is similar to aquatic exercises in water. In clinical practice, isokinetic dynamometers are often used to monitor the progress of individuals during rehabilitation. Nowadays, isokinetic systems have become a frequently used device in the measurement, evaluation and treatment of sports injuries, orthopedics and rheumatologic diseases, neurologic diseases and most problems related to the musculoskeletal system. In addition to the knee, exercises can be performed in these joints for problems in the shoulder, elbow, wrist, trunk, hip and ankle.

Isokinetic systems provide improvements in mobility, balance, strength and postural control with exercise. Current

isokinetic systems have four resistance modes and feedbacks related to these modes (Humac, 2005).

Isometric mode stabilizes the joint for strength exercises at the desired angle.

Isokinetic mode*:* It is used for muscle strengthening with concentric, eccentric loads and deceleration exercises.

Passive mode (CPM)*:* It develops the mobility that the patient needs. It works in a wide range of perspectives, from flat models to complex PNF models.

Isotonic mode*:* In simulated isotonic mode, exercises to restore full range of motion are performed.

Robotic Mode: Although it is in the latest versions of isokinetic systems, it offers many different robotic mode selections. The robotic mode automatically applies CPM and isokinetic modes, and the system works actively (Habets, Staal, Tijssen, & van Cingel, 2018b).

1.1. Why İsokinetic System?

- Measuring the patient's functional capacity and muscular performance,
- Application of passive, isometric, isotonic, and isokinetic exercise programs according to the treatment protocol prepared individually for each patient.
- Quantitative evaluation and monitoring of the treatment program result,
- Comparison of parameters such as muscle strength and joint range of motion of both extremities,
- Determining the degrees of weakness in muscle strength and applying special exercise programs accordingly,
- Determination of agonist-antagonist ratios (Abdelraouf et al., 2022),
- Measurement of workload and fatigue parameters

(Gomes, Santos, Correia, Pezarat-Correia, & Mendonca, 2021),

- Can also measure the sense of proprioception (Keklik et al., 2021).
- Kinematic analysis of movements,
- It is possible to collect data for scientific research by creating a computer-aided recording system.

1.2. Advantages And Disadvantages Of Isokinetic Systems

1.2.1. Advantages

- Visual and auditory feedback during the assessment can motivate the individual being assessed.
- Some of the apparatus of the device actively allows testing in eccentric mode (Brown, 2000).
- Isokinetic systems allow maximum resistance at all angles of normal joint motion.
- It gives clues about the likelihood of individuals being at risk of injury.
- Isokinetic systems allow working at different angular speeds by applying maximum resistance (Foran, 1985).
- Isokinetic assessment is reliable, and the risk of injury during the test is shallow.
- Individuals can work on the affected, intact, or both limbs in sequence if desired.
- The tests can be repeated similarly at different times.
- Different protocols can be created with special isokinetic apparatus.
- Joints can be operated in isolation.
- The range where the muscles are weakest throughout the joint movement can be identified.
- Individuals' data can be stored and compared with later data.

- The device has an apparatus for inertial and isometric testing.
- Provides feedback about fatigue (Yaggie & McGregor, 2002).

1.2.2. Disadvantages

- Devices, apparatus, and software for isokinetic systems are pretty expensive.
- Setting up the device and isolating the movement can be difficult when taking shoulder-related measurements.
- Some factors, such as psychological influences, may affect the test results when the tests are administered (Papciak & Feuerstein, 1991).
- Since only the angular velocity of the device can be controlled, the effort expected from the individual may vary (Foran, 1985).
- Since individuals cannot perform the tests independently, an assessor is needed.
- In isokinetic systems, isolating synergistic muscles, antagonistic muscles and neuromuscular coordination is tough.
- In these systems, it is not possible to train the whole body at the same time.
- It has little originality.
- Generally, it cannot be applied immediately after surgical procedures. The affected tissues are expected to heal (Chan, Maffulli, Korkia, & Li, 1996).
- It needs to be calibrated at regular intervals.
- There is a limited number of test patterns. Sport-specific movement patterns are challenging to simulate.
- The muscle activities performed may not be specific to some sports branches (Gürol & YILMAZ, 2013).

1.3. Isokinetic System Test Parameters:

Angular velocity: The angular displacement per unit time (degrees or seconds).

Force: An exogenous effect in the form of a push or pull applied to an object (Newton)

Weight: The force that gravity exerts on an object. (Newton)

Torque: A measure of the force applied to rotate an object about an axis. (Newton-meter)

Peak torque value (Peak torque): The highest torque value obtained over the entire range of motion at a given angular velocity. It is considered the gold standard for accuracy, precision and reliability among all parameters (Newton-meter).

***The ratio of rotational moment to body weight*:** The value of the torque per kilogram of body mass (Nm/kg)

Workload: The distance a force moves a given resistance. (Newton/meter)

Power: The amount of work done per unit of time (Newton per second or watt).

Endurance: It is the measure of fatigue (endurance) that develops in the muscle (Chan et al., 1996; Özcan Söylev, 2008).

1.4. Isokinetic Testing

Isokinetic testing is a type of muscle strength and joint function assessment that involves measuring force during constant speed movements. This testing method is commonly used in sports medicine, rehabilitation, and research settings to evaluate muscle strength, joint stability, and functional capacity (Humac, 2005).

Here are some critical points about isokinetic testing:

a. ***Constant Speed Movements:*** The term "isokinetic" refers to movements that occur at a constant speed. During isokinetic testing, the speed of the movement is controlled, and the resistance provided adjusts to match the force exerted by the subject. This allows the muscle to contract at a consistent velocity throughout the range of motion (Karatas, Gögüs, & Meray, 2002).

b. ***Isokinetic Dynamometer:*** Isokinetic testing is typically conducted using a specialized device called an isokinetic dynamometer. This machine allows for controlled and measured joint movements while providing resistance that adapts to the individual's force output (Osternig, 1986).

c. Applications:

- ***Rehabilitation:*** Isokinetic testing is commonly used in rehabilitation programs to assess muscle strength imbalances and monitor progress during recovery from injuries (Akaras et al., 2023; Davies, Ellenbecker, Andrews, Harrelson, & Wilk, 2004).
- ***Sports Performance:*** Athletes may undergo isokinetic testing to identify strength deficits, asymmetries, or potential injury risks. This information can be used to design targeted strength and conditioning programs (Akaras et al., 2023).
- ***Research:*** Isokinetic testing is also employed in research studies to investigate various aspects of muscle function, joint stability, and movement patterns (Arikan, Maras, Akaras, Citaker, & Kafa, 2022).

- ***Post-Injury Rehabilitation:*** Isokinetic testing is employed in the rehabilitation process after upper extremity injuries, such as shoulder dislocations, rotator cuff tears, or elbow injuries. It helps in assessing the progress of rehabilitation and identifying areas that need targeted strengthening.
- ***Muscle Imbalance Correction:*** Isokinetics can identify muscle imbalances that may contribute to upper extremity injuries. Rehabilitation programs can then be designed to correct these imbalances through targeted strengthening exercises (Osternig, 1986).
- ***Preventive Training:*** Athletes and individuals at risk of upper extremity injuries can undergo isokinetic testing to identify weaknesses or asymmetries. Preventive training programs can be developed to address these issues and reduce the risk of future injuries.
- ***Patient-Specific Rehabilitation:*** Isokinetic testing allows for individualized rehabilitation programs based on the specific needs and capabilities of the patient. Exercises can be tailored to target the identified weaknesses and address functional deficits.

d. Muscle Testing Protocols:

- Isokinetic testing can be performed on various muscle groups, including the knee, shoulder, ankle, and elbow (Akaras, 2021).
- Standard testing protocols involve concentric (muscle shortening) and eccentric (muscle lengthening) contractions.

- The test may include specific parameters such as peak torque, total work, and power.

e. Data Analysis:

- Results from isokinetic testing are typically analyzed to assess muscle strength imbalances, identify weaknesses or limitations, and guide the development of targeted intervention strategies (Humac, 2005).
- Bilateral comparisons can reveal asymmetries, and the assessment of force curves provides insights into the dynamic aspects of muscle function (Davies et al., 2004).

f. Limitations:

- Isokinetic testing may not fully replicate the complex, multi-joint movements that occur in many sports or activities.
- The cost and space requirements of isokinetic dynamometers can be limiting factors for some clinics or facilities.

It can be said that isokinetic testing is a valuable tool for assessing and monitoring muscle function, particularly in the context of rehabilitation and sports performance. It provides objective data that can inform rehabilitation plans and training programs.

1.5. Isokinetics in Rehabilitation Programs (Progression and Suggestions)

Before entering the isokinetic system, you should warm up with stretching exercises and a bicycle ergometer for 5-10 minutes to protect yourself from possible injuries. At least 3 repetitions of the test should be shown before the movements are

applied.

Athletes should first start exercising with static isometric exercises and then progress toward dynamic activities. Isometric exercises should be done with 10 seconds of contraction and 10 seconds of rest, and 10 repetitions.

In concentric exercises, speeds start from high and are reduced over time. (120 ° to 30 °) On the contrary, it is safer to gradually increase the speed in eccentric exercises.

Endurance exercises are generally performed at speeds of (180° – 300°) and are performed for at least 15 repetitions.

It is necessary to wait at least 8 weeks to work on surgically intervened muscles or joints. Generally, work with the isokinetic device begins 12 weeks after surgery.

Verbal suggestions should be made for better performance. For consistency in measurement results, audio can be recorded and played to the tested individual (Kim & Kramer, 1997).

In order for the athlete to decide to return to sports, the muscle strength of the affected side must reach at least 90% of the healthy side.

The strength ratio between the hamstring and quadriceps in the lower extremity must be at least 60%. In the upper extremity, the ratio of internal rotators and external rotators should again be at least 60%. The expected ratio is 2/3.

1.6. Isokinetic System Contraindications

Isokinetic testing is not performed immediately after surgery, bone fractures, joint instability, severe osteoporosis, edema, joint and bone malignancy, cardiac problems, acute sprains and strains, severe joint limitations, epilepsy and pregnancy (Davies et al., 2004).

2. CONCLUSION

This review underscores the pivotal significance of isokinetic systems in the realms of diagnosis and treatment within the field of physiotherapy and rehabilitation. Isokinetic systems, characterized by their ability to maintain a constant speed of joint movement during assessments, have emerged as indispensable tools for physiotherapists seeking precise insights into musculoskeletal function. Isokinetic devices enable controlled exercise programs with specific and measurable muscle strength assessments. The data obtained guides us in clinical practices and allows us to evaluate the progress of patients in the rehabilitation process objectively. Using isokinetic devices to monitor patients' progress throughout the rehabilitation process offers the opportunity to continually revise and optimize treatment plans. Isokinetic exercises can be designed to achieve specific strength gains by focusing on specific muscle groups. This allows athletes or patients to work towards specific goals. In conclusion, isokinetic devices are essential tools in the field of sports medicine and rehabilitation, and the correct and effective use of this technology can contribute to a faster and more successful recovery process for patients.

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DATA ANALYSIS OF COVID-19 IN AND OUTSIDE OF HUBEI, CHINA AT THE BEGINNING OF THE OUTBREAK

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1. INTRODUCTION

The 2019 novel coronavirus (COVID-19), originating in Wuhan, China, has proliferated to all Chinese provinces and numerous countries worldwide. Evidence of human-to-human transmission has been documented in cases reported in Germany, the USA, and China [1,10]. Notably, in response to the outbreak, Wuhan, the capital city of Hubei province, initiated quarantine measures on January 23, 2020. Subsequently, the entire state or province of Hubei was placed under quarantine by January 24, 2020, with the aim of curtailing the virus's transmission to other cities and states [9].

The investigation into COVID-19 is still in its early stages, and numerous aspects of the outbreak dynamics remain unknown. However, preliminary findings from preprint studies suggest that the reproduction number of COVID-19 falls within the range of 2 to 5 [3,5,6,8,12]. Additionally, an estimated fatality rate of approximately 6.5% has been reported [12]. It's essential to note that as the research progresses and more data becomes available, our understanding of the virus and its characteristics may evolve.

In our study, our primary focus revolves around understanding the trajectory of the COVID-19 outbreak in both

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China and globally. We aim to address key questions concerning the effectiveness of quarantine measures and the quality of healthcare in Hubei province in containing the spread of the virus. To gauge the impact of quarantine, we meticulously monitor the number of COVID-19 cases within and outside of Hubei both before and after the implementation of quarantine measures. This allows us to observe and analyze changes over time in both regions.

In assessing healthcare quality, we specifically examine the per-day case fatality and recovery rates, providing a comparative analysis between Hubei and other regions. These indicators serve as crucial metrics for evaluating the effectiveness of healthcare systems in managing and mitigating the impact of the outbreak.

Beyond these topics, our study delves into a comprehensive discussion on the fatality rate of the outbreak, contributing valuable insights to the broader understanding of the COVID-19 pandemic. Through our research, we aim to contribute meaningful data and analysis to inform ongoing efforts to combat and manage the global impact of COVID-19.

2. DATA ANALYSIS

We visualize the raw COVID-19 data from sources [2, 4, 10] through diverse graphical representations, including graphs, figures, charts, and tables. These visualizations serve to grasp various aspects and dynamics of the outbreak. Our focus lies in analyzing COVID-19 cases, deaths, recoveries, and their daily fluctuations both within and outside Hubei, aiming to assess the effectiveness of quarantine measures and observe trends. Additionally, we examine the daily changes in case fatality and recovery rates to compare healthcare qualities within and outside Hubei. To provide a broader context, we incorporate data on

SARS-CoV from 2003, obtained from the World Health Organization [11], allowing us to draw comparisons between certain aspects of SARS-CoV and COVID-19 in our study.

3. EFFECT OF QUARANTINE IN HUBEI

The quarantine in Wuhan, the capital city of Hubei province, commenced on January 23, 2020, and subsequently, the entire state/province of Hubei was placed under quarantine by January 24, 2020. The question arises as to whether the quarantine was initiated promptly or if there was a delay. Regardless of the timing, our primary focus is on assessing the impact of these measures on the spread of the COVID-19 outbreak. The crucial factor is not just when the action was taken but understanding how effective it proved in curbing the dissemination of the virus

The quarantine measures were implemented on the same day when 17 individuals succumbed to COVID-19, and approximately 24% of the cases had already spread beyond Hubei. By January 26, 2020, this percentage had surged to 49%, indicating that, despite the official initiation of the quarantine on January 23, 2020, its effectiveness was limited. Consequently, the tangible impact of the quarantine only became apparent after January 26, 2020, suggesting a delay in its efficacy. The data reveals that, as of January 26, 2020, nearly half of the COVID-19 cases were already outside Hubei, as illustrated in Figure 2.

Examining the total cases in and outside Hubei by February 8, 2020, as illustrated in Figure 1, indicates a discernible impact of the quarantine measures in Hubei. Initially, by January 26, 2020, the number of COVID-19 cases did not significantly differ inside and outside Hubei. However, a notable trend emerges thereafter, as depicted in Figure 2. The percentage of COVID-19 cases outside Hubei begins to decline from January 26, 2020, marking a positive shift. The data shows a reduction

from the initial 49% to the current 28%, underscoring a gradual containment of the outbreak beyond Hubei. This suggests that, despite a delayed onset of efficacy, the quarantine measures eventually prove instrumental in curbing the spread of COVID-19 beyond the borders of Hubei.

Figure 1: Left graph: the cumulative COVID-19 cases in and out of Hubei. Right graph: the differences of cumulative COVID-19 cases (cases in Hubei – cases outside of Hubei).

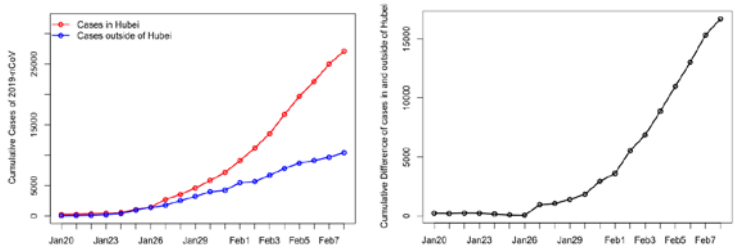
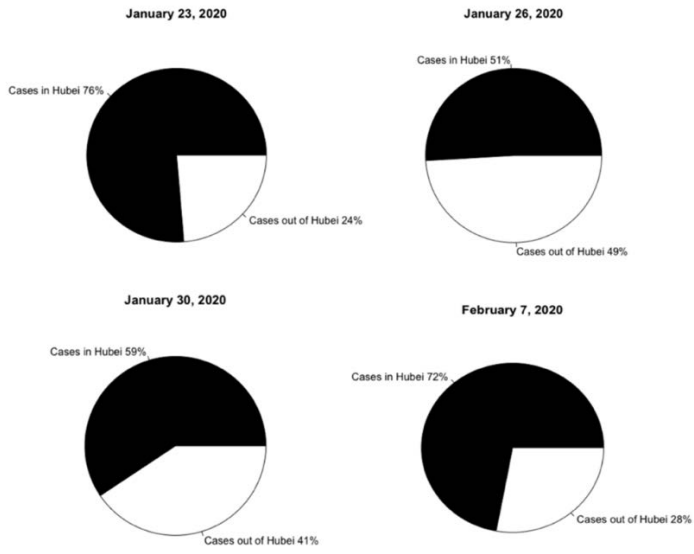


Figure 2: Pie charts of COVID-19 cases in and out of Hubei for different dates



4. CASE FATALITY RATES (CFRS) AND HEALTH CARE STATUS IN/OUTSIDE HUBEI

The local governor of Wuhan faced criticism for a belated decision on the quarantine, as nearly half the population had already departed the city by January 23, 2020. The dilemma of whether individuals should stay or leave a city during an outbreak raises questions about the most effective containment strategy. Typically, to mitigate the spread of COVID-19, it is advisable to retain residents within the city and implement isolation measures. However, in this instance, data analysis suggests that decreasing the population density from the epicenter has, fortunately, contributed to a reduction in the fatality rate of the global outbreak, as indicated in Table 1.

Despite the virus's spread to various regions in China and other countries, the case fatality rate remains notably low outside Wuhan, particularly beyond Hubei. The outbreak in Hubei has been approximately nine times more lethal than in other areas. This discrepancy implies a potential disparity in healthcare status, with Hubei facing challenges in comparison to regions outside the province. Consequently, the probability of surviving the virus outside Hubei appears significantly higher.

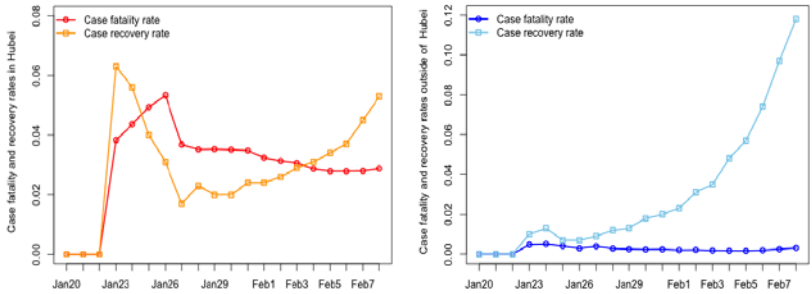
Quantifying healthcare status both within and outside Hubei poses a challenge due to the absence of direct analytical data. Nevertheless, we can derive some preliminary insights into the healthcare status of hospitals in and outside Hubei by examining their case fatality and recovery rates.

Table 1. Case fatality rates (CFR) of COVID-19 in and outside of Hubei

Date	CFR in the Globe	CFR in Hubei	CFR outside of Hubei
1/23/2020	0.028	0.0383	0.0048
1/24/2020	0.028	0.0437	0.0051
1/25/2020	0.028	0.0494	0.0041
1/26/2020	0.029	0.0534	0.0029

1/27/2020	0.024	0.0368	0.0040
1/28/2020	0.022	0.0352	0.0028
1/29/2020	0.022	0.0353	0.0025
1/30/2020	0.022	0.0351	0.0023
1/31/2020	0.023	0.0348	0.0024
2/1/2020	0.021	0.0324	0.0020
2/2/2020	0.022	0.0313	0.0021
2/3/2020	0.021	0.0306	0.0018
2/4/2020	0.020	0.0287	0.0017
2/5/2020	0.020	0.0279	0.0016
2/6/2020	0.020	0.0280	0.0019
2/7/2020	0.021	0.0281	0.0025
2/8/2020	0.022	0.0288	0.0032

Figure 3. Left graph: Per day case fatality and recovery rates in Hubei. Right graph: Per day case fatality and recovery rates outside of Hubei



If we look at the case fatality and recovery rates in Hubei, we see that the case recovery rate is below the case fatality rate between January 25 and February 3, 2020, and then starts to go above the case fatality rate. On the other hand, the case recovery rate outside of Hubei is always above the case fatality rate (see Figure 3). Thus, it is fair to say that the health care performance outside of Hubei is better depending on this comparison.

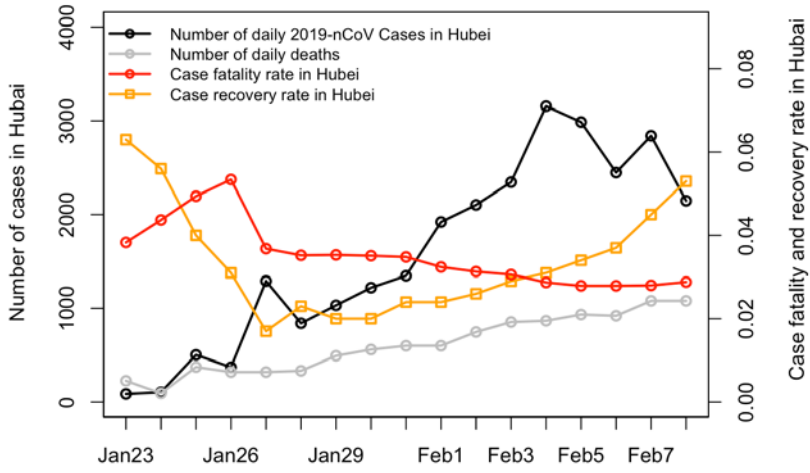
As of 02/08/2020, 780 people died, and 1,439 people recovered from COVID-19 in Hubei. On the other hand, 33

people died, and 1,230 people recovered outside Hubei. Thus, the chance of survival due to COVID-19 is higher outside of Hubei so far. The case fatality rate is now about 2.9% (0.029) in Hubei, but the percentage may increase dramatically and the COVID-19 can be more latent than SARS (fatality rate was 10%) if the proportion in the numbers of deaths and recovered keep track this pattern in Hubei. But, depending on the sharp increases in the case recovery rate in and out of Hubei (see Figure 3), we do not think this case is going to happen. The sharp increases in recovery rate imply that the proportion of recovered people will increase gradually.

When we look at the beginning of the outbreak in Hubei, especially January 22, 2020, the recovery rate is greater than the case fatality rate, and the recovery rate was at its maximum level, which implies the performance of Hospitals was good in the beginning of the outbreak in Hubei. But the recovery rate starts to decay very quickly and somehow balanced between 0.02 and 0.03. We believe that this decrease is related to the increase in daily change in the numbers of COVID-19 cases (See Figure 4).

However, the trend is changing and after January 31, 2020, the case recovery rate starts to increase even if the numbers of daily COVID-19 cases increase in Hubei. It means that the quality and performance of Hospitals in Hubei is increasing even if the number of daily cases is rising. Moreover, the case fatality rate is decreasing after January 26 since daily COVID-19 cases and the case recovery rate are increasing. But this trend is also changing, now the case fatality rate starts to increase after February 5, 2020 due to mainly decrease in daily cases of COVID-19 and increase in number of deaths (see Figure 4).

Figure 4. Rate of changes in COVID-19 cases and case recovery rates between January 23 and February 2, 2020.



5. MIXED CASE FATALITY RATE (MCFR)

Let me first give the definition of case fatality rate (CFR), which is one of the indexes that measures the severity of an outbreak/diseases, and calculated as

$$CFR = \frac{Number\ of\ Deaths}{Number\ of\ cases} \qquad (1)$$

where "*Number of Death*" denotes number of deaths due to a specific outbreak or diseases, and "*Number of Cases*" denotes the number of infected people due to the same specific outbreak or diseases (multiplying equation (1) by 100, we obtain this rate in terms of percentage). Estimation fatality rate of an outbreak is really hard during the outbreak, and it is biased since outcomes of all the cases (patients) are unknown (death or recovered). We don't know how many of them will recover or die during the outbreak. Thus, we may underestimate or overestimate fatality rate of COVID-19.

As we know the case fatality rate of the outbreak will converge to the fatality rate of this outbreak at the end when the outcomes of all patients are known (death or recovered). Similarly, the following equation (2) will also converge to the same fatality rate at the end of the outbreak when all the outcomes of patients are known (death or recovered).

$$\left(\frac{Number\ of\ Death}{Number\ of\ Death + Number\ of\ Recovered}\right) = Death - Recovery\ Rate \quad (2)$$

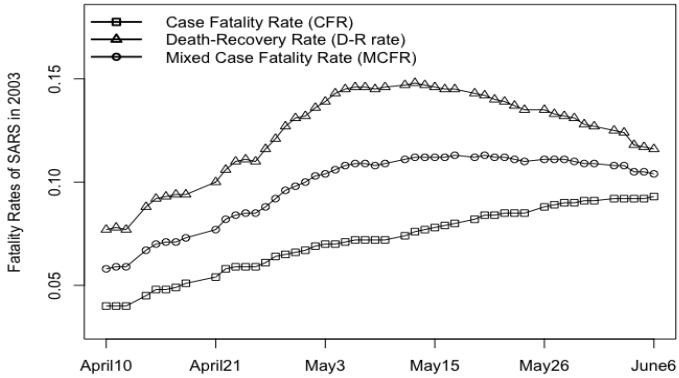
where "*Number of Recovered"* stands for the number of recovering from a specific outbreak or diseases. This estimate is also very biased during the outbreak since we still do not know how many patients will recover or die.

Equation (1) and (2) are equal when all the outcomes of patients are known. Thus, the following equation (mixed case fatality rate) also will converge to the same fatality rate when all the outcomes of patients are known.

$$\frac{CFR + \left(\frac{Number\ of\ Death}{Number\ of\ Death\ +\ Number\ of\ \ Recovered}\right)}{2} = Mixed\ Case\ Fatality\ Rate \quad (3)$$

We can use any of these equations during an outbreak to get some idea about the fatality rate of the outbreak, but we may make much better projection for the fatality rate when we use equation 3, which we call mixed case fatality rate (MCFR). For Example, see Figure 5 for the daily change of CFR for SARS. The fatality rate of SARS is about 10% [11] and the mixed case fatality rate makes a better projection for the fatality rate of SARS during the outbreak (see Figure 5). Thus, beside the CFR, we also may use this mixed fatality rate for any outbreak.

Figure 5. Daily change of (Case) fatality rates of SARS.



6. PROJECTION FOR THE FATALITY RATE OF COVID-19 IN HUBEI AND IN THE GLOBE

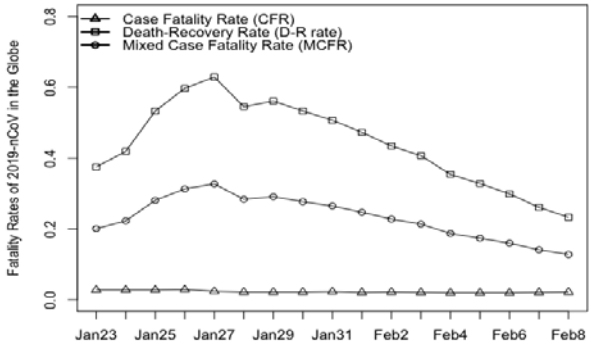
In this part, we use the CFR, Death-Recovery rate (D-R rate), and mixed CFR (MCFR) to be able to get some sense and knowledge about the fatality rate of COVID-19. For the COVID-19, the CFR is underestimating the fatality rate of this outbreak since the number of cases and its daily change is very high, and we assume as if all the patients will recover when we calculate daily CFR of the outbreak, but we know in reality that some of these patients will die. Therefore, we expected CFR will be larger than its current value at the end of the outbreak. We don't know how large it will be, but we expect that it will start to increase right after reaching the peak of the outbreak in terms of daily numbers of COVID-19 cases. Thus, we expect that the fatality rate of COVID-19 will be larger than its current CFR.

On the other hand, the D-R rate is overestimating the actual CFR. When we observe the daily change of the D-R rate (see Figure 6), we see a sharp decay in D-R rate. It will continue

to decrease as it approaches the actual fatality rate of COVID-19, and then will stay around the actual fatality rate. Thus, CFR is underestimating, and D-R rate is overestimating the actual fatality rate of this novel coronavirus outbreak.

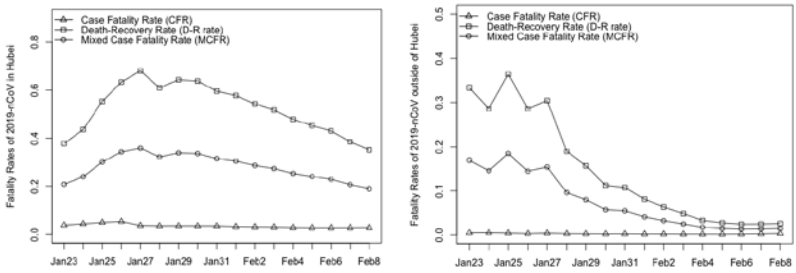
Therefore, it is better to use MCFR besides these rates to get more information about the actual fatality rate of COVID-19. We track the daily change of these rates to see and estimate where the actual fatality rate will end up (see Figure 6 and 7). When we check the daily change of the rates, especially CFR and MCFR, the MCFR is decreeing and its daily change is faster than daily change of CFR. When we also check the daily change of the CFR (see Table 1), it has started to increase, but very slowly. Note that these two rates will converge to the same value end of the outbreak. Thus, MCFR and CFR will intercept somewhere about average of these rates. But it will be close to the CFR since daily change of CFR is smaller than daily change of MCFR. Depending on the value of these rates on February 8, 2020 (see Figure 6), the average of these rates is about 0.074 on February 8, 2020. Thus, the projected fatality rate of COVID-19 will be between 2.2% and 7.4% in the Globe but will be close to the 7.4%.

Figure 6. Daily change in fatality rates of COVID-19 in the globe



Since the virus spread very quickly ([3,5,6,8,12]) in a highly populated region, we have a very large number of daily cases. Thus, the large number of cases dominate the CFR and keep it low. We expect an increasing trend in CFR right after reaching the peak of the outbreak. Now CFR is about 2.2% in the Globe and there is no significant difference in its daily changes. We believe the actual CFR will end up between MCFR and CFR but will close to the CFR since its daily change is much smaller than the daily change of MCFR (see Figure 6). Therefore, we believe the actual CFR will be smaller than 7.4%, which is obtained by average of MCFR and CFR on February 7, 2020, and larger than 2.2% in the Globe. Similarly, these percentages are 2.9% and 10% in Hubei and 0.32% and 0.89% outside of Hubei. (see Figure 7 for daily change of fatality rates).

Figure 7. Case Fatality rates of COVID-19 with different track of fatality rates

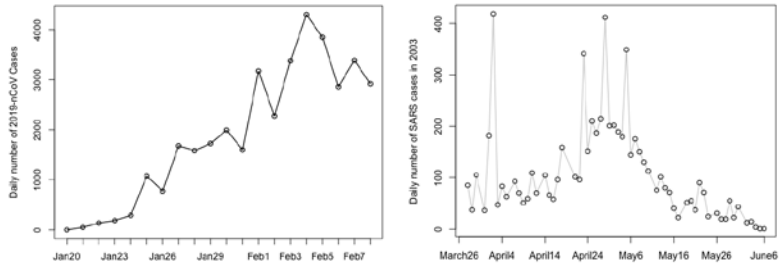


7. COMPARISON OF CASES IN SARS AND COVID-19

When we compare the daily change of cases (see Figure 8) at the beginning of both outbreaks, the average of daily change is about 132 in SARS, but this number is about 1,806 cases in COVID-19 so far. The difference is really huge, and we have not yet reached the peak of COVID-19 outbreak yet (we have a sign

of reduction in daily change of cases, but we are not sure whether it is going to reach its peak that early. Thus, we consider we still have not reached the peak of the outbreak). Most probably this average daily change will be larger than 1,806. Thus, we believe the number of cases in COVID-19 will be at least 13.7 times larger than SARS. In SARS, the number of cases was about 8096 [11], and with this rough estimate, the number of cases might be at least 110,915 in COVID-19.

Figure 8. Daily changes of COVID-19 (left graph) and SARS (right graph)



Assuming that the estimate of COVID-19 cases will be about 110,915 in the Globe, then depending on the current CFR in the Globe, the number of deaths will be about 2,411 in this outbreak. Also, depending on our rough estimate for actual CFR, which is between 2.2% and 7.4% depending on the current data, the number of deaths will be between 2,440 and 8,207.

8. DISCUSSION AND CONCLUSION

According to our data analysis of the early stage of the novel coronavirus by February 8, 2020, the quarantine measures implemented in Hubei have demonstrated effectiveness, despite initial inefficiencies observed on January 26, 2020. On the latter date, the percentage of COVID-19 cases outside of Hubei stood

at 49%, but there has been a notable decline to 28% by February 8, 2020. This suggests a positive trend, indicating that the quarantine measures have been successful in reducing the spread of the virus beyond the borders of Hubei over the analyzed period.

A significant observation from our analysis pertains to the healthcare quality in Hubei, particularly in Wuhan. By February 8, 2020, most reported deaths were concentrated in Wuhan, with 608 deaths and 14,982 cases [2,4]. The case fatality rate in Wuhan stands at approximately 4.1%, compared to the overall Hubei rate of 2.9%. In contrast, the case fatality rate outside Hubei is notably lower at about 0.32%. This discrepancy highlights potential limitations in hospitals and healthcare quality in Hubei, especially in Wuhan. While the exact reasons remain unknown due to a lack of data on hospitals and treatment procedures, this may be linked to factors such as a restricted number of hospitals, healthcare personnel shortages, or inadequate medical equipment and supplies in this densely populated region when compared to global healthcare standards. Addressing these limitations is crucial to enhance healthcare quality in Hubei, particularly in Wuhan. The current outbreak in Hubei has been approximately nine times more lethal than in other areas, emphasizing the urgent need for improved healthcare infrastructure. The probability of surviving the virus is notably higher outside Hubei, underscoring the importance of bolstering healthcare resources within the region.

Our initial data analysis of the Case Fatality Rate (CFR) for COVID-19 suggests varying fatality rates across different regions. Globally, the estimated range is between 2.2% and 7.4%, while in Hubei, the epicenter of the outbreak, the projected range is wider, spanning from 2.9% to 10%. Conversely, outside of Hubei, the fatality rate is anticipated to be notably lower, falling within the range of 0.32% to 0.89%. These figures are rough estimates and may be subject to refinement as our data analysis

progresses. Ongoing monitoring and further research will contribute to a more accurate assessment of the COVID-19 fatality rates worldwide.

In our comparative analysis of the early stages of the SARS and COVID-19 outbreaks, we observed that the number of reported COVID-19 cases is projected to reach approximately 110,915 or potentially exceed this figure. If this rough estimate aligns closely with the actual number of cases once all outcomes, including deaths and recoveries, are known, then the anticipated number of deaths globally is estimated to fall within the range of 2,440 to 8,207. It's important to note that these projections are based on early-stage data and are subject to refinement as more information becomes available. Continuous monitoring and further analysis will contribute to a more accurate understanding of the impact of COVID-19.

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ANALYSIS OF DEVELOPMENTS IN HEALTH SCIENCES

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