Clostridial infections in the world and in Slovakia in the patient safety context

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Introduction

Infection with Gram-positive sporulating bacteria Clostridium difficile (CDI) is currently a serious health problem worldwide due to its increasing incidence and mortality. In hospitalized patients, it is the most common cause of diarrheal disease, and healthcare professionals face many challenges related to its identification, treatment, and prevention of its transmission. Evidence-based risk reduction strategies are essential to ensure a safer environment of healthcare facilities in the event of a suspected or confirmed CDI. These strategies include components for the prevention of standard infections and contact measures, care for the environment and prudent use of antibiotics.

The rise in incidence of CDI is connected with an increase in financial costs which for the European Union make € 3000 million per year, and this number is expected to double over the next three decades [1]. The onset of the disease is most important for nurses, as they are in a key position in improving the quality of healthcare through interventions and strategies for the area of patients’ safety. In an effort to reduce the rate of healthcare-associated infections, it is currently recognized as a measure of hospital quality. Practice shows that while the same prevention interventions may be successful in one hospital, they may fail or be less successful in another. We assume that organizational factors, the involvement of nurses in the implementation of prevention procedures and the perception of patient safety by nurses are the main reasons of that.

Core

The incidence of CDI is increasing worldwide. In 2001, this incidence increased to 50 cases per 100,000 inhabitants and in 2005 to 84 cases per 100,000 inhabitants (ie a threefold increase compared to the incidence in 1996). In England, in 1991, CDI was identified as the primary cause of death in 499 patients, and in 2006 in 3,393 patients caused by ribotypes shortly thereafter in the Netherlands. The occurrence and rapid spread of this epidemic strain was related to its resistance to a frequently used group of antibiotics, the newly developed fluoroquinolones (levofloxacine, moxifloxacine) [3].

The incidence in Europe is 41 cases per 100,000 hospitalized patients. The most common epidemic ribotypes are ribotypes 01, 002, 014 and 078. A 2008 study, covering 34 European countries, reported that ribotype 027 occurred in only 5% of all cases. The global problem of the increasing appearance of CDI also applies to Slovakia. The Public Health Office of the Slovak Republic gives the estimated number of Clostridium difficile (CD) colonized patients in Slovakia of 7-11% in hospitalized patients, 5-7% in patients in social-care facilities and approximately of 2% in outpatients [4].

The European Center for Disease Prevention and Control (ECDC) organized a Europe-wide point prevalence survey of healthcare-associated infections in 2012, showing that 48% of gastrointestinal infections in hospitals were caused by C. difficile and 7.7% of all health care CDI-related infections were caused by nosocomial transmission. C. difficile was on the eighth place in the list of pathogens causing nosocomial infections. Data from Germany have shown that the incidence of CDI in hospitals is 2-4 times higher than nosocomial infections caused by MRSA [5].

Since 2013, Clostridium difficile belongs to one of the five most common pathogens of nosocomial infections in Slovakia. In 2017, with 17.3% it became the most common originator and the cause of all nosocomial infections. In 2017, in Slovakia, most nosocomial CDI cases (88.5%) were reported from internal medicine departments, 7.4% of cases of CDI-NN occurred in surgical departments, 2.8% in anaesthesiology and resuscitation departments and 1.1% in pediatric departments. The age distribution of reported CDI cases in Slovakia in 2010–2017 shows that the risk of infection increases with age, with the elderly representing the largest risk group, followed by young children. The incidence of patients aged 65 and over was 9.8 per 10,000 inhabitants in Slovakia. The incidence in
100 children under 1 year of age was 2.6 per 10,000 inhabitants in Slovakia. The average age of CDI patients during the study period was 68.6 years [6]. The following table shows the incidence of nosocomial infections caused by CDI in 2019 in the hospitals of the WORLD HEALTH network presented by the main epidemiologist in the World of Health and ProCare network.

Table. Incidence of Clostridial infections in hospitals of the World Health network (Skálová, 2019)

| Hospitals WH         | Number of reported NN | of which number of reported CDI NN | Incidence of patients with CDI, % |
|----------------------|-----------------------|-----------------------------------|----------------------------------|
| Košice “Železničné zdrav” | 28                    | 1                                 | 3.57                             |
| Rožňava              | 199                   | 15                                | 7.54                             |
| Vranov n/T           | 152                   | 15                                | 9.87                             |
| Partizánske          | 132                   | 9                                 | 6.82                             |
| Svidník              | 149                   | 8                                 | 5.37                             |
| Trebišov             | 194                   | 5                                 | 2.58                             |
| Michalovce           | 250                   | 40                                | 16.00                            |
| D. Streda            | 269                   | 47                                | 17.47                            |
| SNV                  | 234                   | 19                                | 8.12                             |
| Rimavská Sobota      | 162                   | 12                                | 7.41                             |
| B. Štiavnica          | 32                    | 8                                 | 25.00                            |
| Žiar n/Hronom         | 117                   | 42                                | 35.90                            |
| Humenné              | 127                   | 24                                | 18.90                            |
| Topoľčany            | 220                   | 17                                | 7.37                             |
| Galanta              | 222                   | 23                                | 10.36                            |
| SPOLU                | 2487                  | 285                               | 11.46                            |

Clostridial infections

Clostridium difficile is a gram-positive bacterium that was first isolated from the stool of healthy newborns in 1935 by Hall O’Tolle. The bacterium was originally named Bacillus difficilis, which was supposed to express problems and difficulties in its isolation [5].

In 1978, CDI was identified as the cause of antibiotic-related colitis. This bacterium is commonly found in nature and in wastewater and surface water. Another, still unconfirmed, source of bacteria in the community is probably pets and particular meat products [7].

The virulence of C. difficile is given by its ability to form resistant spores and produce toxins. The spores are acid-resistant, they are able to survive transport through the stomach into the small intestine, where they germinate and the vegetative cells produce toxins [8]. In its spores, the bacterium can survive harsh environments and conventional sterilization techniques. CDI spores are resistant to high temperatures, ultraviolet radiation, strong chemicals and antibiotics. Spores are resistant to antibiotics, they can remain in the gastrointestinal tract and potentially contribute to recurrent diseases after treatment and eradication of vegetative CDI.

Currently, three toxins are known: toxin A – enteroxin damaging intestinal epithelial cells and reducing the efficiency of the immune system, toxin B – cytotoxin causing necrosis and ulceration of affected tissues and the formation of pathognomonic patches, the third is the so-called binary toxin, the effects of which are currently not fully known [3]. The production of both, A and B toxins is a major determinant of CDI virulence, i.e. C.difficile strains that do not produce toxins do not cause disease (are not pathogenic) [9].

Risk factors

The main risk of acquiring CDI is present within four weeks after antibiotic treatment, representing 40% to 60% of cases [10]. Other risk factors are age (over 65 years), comorbidities, hospitalization in the last three months and stay in a facility for the long-term sick or in a nursing home [11]. Treatment with proton pump inhibitors also increases the risk of CDI, but enteral nutrition does not play a significant role. Possible risk groups include patients with weakened immunity or immunodeficiency and patients with chronic inflammatory bowel disease [12].

Clinical condition

CDI infection occurs by the fecal-oral route due to ingestion of spores that are resistant to the environment. During the gastrointestinal transition, bile acids and other substances stimulate the germination of vegetative growth forms, these produce toxins depending on the surrounding microflora (microbiota) [13]. Typical manifestations of CDI are abdominal cramping, extensive diarrhea (mucoid, greenish, foul-smelling, and watery stools) corresponding to type V-VII in the Bristol scale of stool types, fever and leukocytosis, which may occur several days after the start of antibiotic treatment or up to 8-10 weeks after its end. If the stools are not large and bulky, in immobile patients, this condition can be mistaken for sudden stool incontinence. The main symptoms of colitis
include diarrhoea, ileus and toxic megacolon [7]. Ileus is a
disruption of intestinal patency. Toxic megacolon is
characterized by enlargement of the intestine along with a
significant elevation of inflammatory parameters. Severe
course may be accompanied by other symptoms: fever, signs
of shock and peritonitis, leukocytosis >15,000, shift of blood
count to the left, increased creatinine and others [8]. The feared
complication is recurrences, which may occur several days
after the end of diarrhoea, usually occurring within 2 months
after the previous attack. They may have an easier or more
difficult course. After the first attack, the probability of
recurrence is in the range of 15-25%. If a second CDI attack
has occurred, the probability of further recurrence is 40-50%.
They are not caused by antibiotic resistance, but by re-infection
caused by spores from the patient's surroundings. A patient
with recurrent attacks of Clostridial colitis is at risk of
disruption of the internal environment, dehydration and overall
mental and physical exhaustion of the body. Frequent
recurrences are the second leading cause of death from
Clostridial infection [4].

**Diagnosis**

Diagnosis requires detection of C. difficile toxins or
C. difficile producing toxins in a diarrhea stool sample.
Diagnostic tests can be divided into tests for C. difficile
product detection (eg Glutamate dehydrogenase, volatile fatty
acids, toxins), tests for the detection of CDI genes (16S rRNA,
toxin genes) and cultivation methods for the isolation of toxin-
producing bacteria [14].

**Treatment**

Evidence of toxigenic CDI requires prompt treatment
adjusted to the possible risk. This usually leads to clinical
improvement within 48 to 72 hours. If possible, antibiotic
treatment that has resulted in toxigenic CDI should be
interrupted or changed to a less colitogenic drug, such as
tetracycline or tigecycline. Continued systemic antibiotic
treatment increases the likelihood of recurrence. Naturally,
adequate rehydration therapy should also be given. Motility
inhibitors should be avoided and treatment with proton pump
inhibitors should be discontinued if possible [12]. Oral
metronidazole is a first-line drug for simple CDIs, but should
not be used for severe CDIs. This is because in such cases the
response to treatment is weaker (73% vs. 81%). In the initial
treatment of severe CDI, oral vancomycin is a first-line drug;
alternatively, oral fidaxomycin may be used [15].
Colonoscopic stool transmission (stool transplantation) may be
recommended based on better acceptance and prevention of
bacterial contamination of the small intestine by faecal
microbes, in addition to its higher success rate. Within two
weeks after stool transplantation, a highly diverse protective
donor flora develops, predominantly of the natural Bacteroides
species [16].

**Prevention of the onset and spread of infection**

Two types of measures are essential: isolating infected
patients and disinfecting the environment in which they are
housed. Patients should be isolated in separate rooms with their
own toilet, in case of infection of several patients it is possible
to place them in one room. It is advisable to set aside caregivers
who use protective equipment to protect them from C. difficile
infection before entering the room. The most important thing
is the consistent use of disposable gloves and hand washing
according to the valid recommendations. It is not advisable to
use alcoholic solutions for hand washing, as they may lead to
the germination of C. difficile spores. The patient should be
treated in an isolation regimen for the entire duration of
diarrhoea. After discharge of the patient(s) with CDI, thorough
mechanical cleaning and disinfection of all surfaces and
objects in the patient's room with sporicides must be
performed [4].

**Patient safety**

The definition of patient safety emerged from the
healthcare quality movement and is defined as "prevention of
patient harm" [17]. Emphasis is placed on a care delivery
system that prevents mistakes, learns from mistakes that may
occur and is built on a safety culture that involves healthcare
professionals, organizations and patients. Safety is the
foundation on which all aspects of quality of care are being
built [18]. Recently, attention has focused on understanding the
common attitudes, beliefs, values and assumptions that
underpin people's safety activities and the potential importance
of these common characteristics in initiating lasting changes in
patient safety. In the literature, these common characteristics
are often referred to as an organization's "safety culture" [19].
The pursuit of these goals are the common beliefs and
values of the organization that set them apart from the others.
It is generally accepted that it is a learned entity. The proposals
range from a very simple: "the way we do things here" to
highly complex ones, involving common basic assumptions,
external adaptation and internal integration. Organizational
culture includes not only what the members of the organization
have learned, but also what they believe in. Includes
perceptions and practices shared within the organization and
not just on the basis of the values held by individual members.
This model of shared beliefs and values makes sense to
members of the organization and provides them with rules of
conduct in their organization. Organizational culture and
behaviour can therefore be seen as a model system of
perceptions, meanings and beliefs that facilitates and guides
individual behaviour at work [20].

**CDI prevention procedures related to patient safety**

Patient safety procedures are defined as "procedures
that reduce the risk of adverse events related to the exposure to
medical care throughout the range of diagnoses or conditions". This definition is specific but relatively incomplete, as several
practices have not been researched properly for respect of their
effectiveness in preventing or mitigating damage. In the past,
we have often observed the responsibility of nurses for patient
safety in the narrow aspects of patient care, such as the
prevention of treatment errors and the prevention of patient
falls. Although these dimensions of safety remain important in
the nursing field, the breadth and depth of patient safety and
quality improvement are much greater. Error analyses relate to
"non-compliance with standard operating procedures, poor
leadership, errors in communication or teamwork, overlooking
or ignoring individual vulnerabilities, and losing track of objectives" [21].

CDI prevention measures include patient placement, use of personal protective equipment (gloves, coats, masks, and eye protection), hand hygiene, decontamination, and appropriate laundry and waste material handling. Isolation involves the physical separation of patients with infections (or suspected of infections) to interrupt the transmission of potential pathogens between other patients, staff and visitors, and it has historically been used to control for preventing and spreading of the infectious diseases [22].

The marking of the patient’s room is a reminder to the medical staff about the necessary procedures for an isolation. Although there is much discussion about the effectiveness of isolation measures, the practice is based on reliable theoretical justification and is generally accepted. Nurses and all healthcare professionals must follow strict protocols without compromising patient safety. Isolation or other forms of restraint affect the well-being and freedom of patients and prescribed environments and isolation procedures bring barriers to physical, sensory and psychosocial needs of patients [23], which, in our view, also places an invisible burden on staff.

**Adherence to organizational principles**

Effective organizational rules in a medical facility require compliance with organizational rules and procedures on the part of its employees. However, this is far from being universal. The degree of suboptimal compliance is still reported in basic procedures such as hand hygiene and antibiotic prophylaxis in surgery. A conceptual seminar survey conducted by Cabana et al. found that nurses' compliance with the guidelines could be hampered by a number of obstacles, such as: lack of knowledge, lack of familiarity and lack of self-commitment and efficiency in implementing good practices [24].

**Adherence to prevention procedures and workload**

The vigilance of bedside nurses is essential for their ability to ensure patient safety. It is therefore logical that with the growing number of patients, the ability of nurses to provide safe care will eventually be compromised. Several studies have shown an association between the number of nurses and patient safety, documenting an increased risk of patient safety events, morbidity, and even mortality with increasing numbers of patients per nurse. The nurse-patient ratio is only one aspect of the relationship between workload and patient safety. The overall burden on nursing is also likely to be related to increased patient turnover [25], which in our opinion is also associated with an increased risk of non-compliance with CDI transmission prevention procedures, even though the total number of nurses is considered to be adequate.

**Influence of management on compliance with prevention procedures**

Strong leadership has always been considered essential for successful campaigns for control and prevention of infections. Some authors confirm that hospitals with more effective management have demonstrated better hand hygiene and better managed procedures of dressing and using gloves among staff. They are also less likely to report obstacles to implementing control and prevention of communicable diseases. Effective leadership styles can also have a very positive effect on prevention outcomes, while too strong top-down control can have a negative effect on nurses' job satisfaction and their ability to respond appropriately [26].

**The impact of job satisfaction on adherence to prevention procedures**

There are very few studies that have somehow identified the relationship that exists between positive job satisfaction and adherence to infection prevention practices. However, a consistent relationship between low levels of employee satisfaction and adverse outcomes such as increased transmission of infections, mortality, has been demonstrated, even though the mechanisms and the direction of causation remains unclear [27].

**Culture of communication**

Unless there is a proper culture of communication in the organization with staff, patients and nurses, they will not have sufficient knowledge of the risks of infection and of the care needed to prevent CDI. In addition, without multi-organizational communication, it will be difficult to gain a proper understanding of effective patient safety strategies in hospitals that show high levels of performance [28].

**Impact of training on adherence to procedures**

In addition to dissemination of information, the aim of the training should be to persuade participants to believe in their ability to achieve the desired change through their behaviour. Self-efficacy theory identifies four ways to influence the change of behaviour. These include: performance regulations that focus on changing beliefs about a person's ability to perform desired behaviour, continuing education that modifies self-efficacy by observing others, verbal persuasion that modifies behaviour through significant interaction with others, and emotional strain that supports the idea that more relaxed, less stressed participants would rather follow the prescribed procedures and perform proper hand hygiene. Behavioural change forces individuals to move away from their comfort zone, so it is often undesirable. It should therefore come as no surprise to find varying degrees of non-compliance with a change in behaviour. If individuals do not perceive the new behaviour as rewarding enough to accept it, all kinds of resistance will be observed. The main cause of active resistance are the extensive difficulties with the integration of habits that result from previous clinical training and daily work routine. Saint et al. ascribes insufficient adherence to control and prevention procedures to either "active defendants" or "organizational advocates". Active resistance is described as a lack of full confidence of competent authorities about their commitment to new procedures. On the other hand, organizational criminals are defined as individuals who are generally executive managers at a medium to high level and who hinder or postpone certain activities without overt and public expression of active resistance. These (professional) individuals resist the change by increasing the effort required to implement evidence-based practices [29].
Monitoring procedures in the context of patient safety

In the last decade, there has been an increasing pressure to increase the use of quality indicators and health care measures, in particular infection rates. Rates for healthcare associated infections have been designed as an effective indicator of hospital system failure and have been used as indicators of professionalism of the staff, of the training, of organizational stress, management failure, inadequate systems, reliability and of the resilience. They provide a space to identify organizations whose organizational culture has a more unfavourable aspects of treating patients with CDI. Preventive measures to control the infection are the most preventative measures to control the infection are the most effective strategies in order to maximize the quality of the care provided. Managing the diarrhoea and taking preventive measures to control the infection are the most unfavourable aspects of treating patients with CDI. Preventive measures include contact isolation, hand hygiene, and reorganization/coordination of nursing care and the wards. Preventive measures are time consuming and significantly increase the workload of nurses in combination with the care of patients with uncontrollable frequent diarrhea attacks, which may affect their perception of patient safety and ability to concentrate their efforts to adhere to the procedures.

The incidence of CDI is rising and is beginning to affect a population that was previously considered low-risk. Nurses need to integrate CDI knowledge and skills into their practice to combat the international epidemic of multidrug-resistant organisms, as they play a crucial role in patient safety due to their constant presence at the patient's bedside. They make up the largest group of hospital staff and are familiar with the patient's everyday clinical condition, so they can effectively engage and help reduce Clostridium difficile infection (CDI) in hospitals.

We can find many positive reasons to create and maintain a safe environment. One of the most important is that we do this to protect our patients. As Menšík et al. [31] propose, nurses are in the best position to improve the quality and safety of patient care. Quality professional and especially safe nursing care requires the nurses to be able to identify and solve obvious and hidden problems of the nursing practice.

Conclusions

It is necessary to build on the efforts of research on risk perception from other disciplines to understand how nurses think and decide about the CDI problem. This can help us to inform on the development of effective management and communication strategies in order to maximize the quality of the care provided. Managing the diarrhoea and taking preventive measures to control the infection are the most unfavourable aspects of treating patients with CDI. Preventive measures include contact isolation, hand hygiene, and reorganization/coordination of nursing care and the wards. Preventive measures are time consuming and significantly increase the workload of nurses in combination with the care of patients with uncontrollable frequent diarrhea attacks, which may affect their perception of patient safety and ability to concentrate their efforts to adhere to the procedures.

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The analysis of the scientific literature found that Infection with Gram-positive sporulating bacteria Clostridium difficile (CDI) is currently a serious health problem worldwide due to its increasing incidence and mortality and it is the most common cause of diarrhea in hospitalized patients. In this work we analyze preventive measures, which include contact isolation, hand hygiene and reorganization/coordination of nursing care and of the ward. Preventive measures are time-consuming and significantly increase the workload, which can affect the perception of the patient's safety level by nurses and the ability to concentrate their efforts to adhere to good practices for preventing the transmission of the infection. We also emphasize the crucial role of nurses in increasing patient safety due to their constant presence at patient's bedside. knowing the patient's microbiome after bacteriotherapy in the case of recurrent diarrhea associated with Clostridium difficile. J Clin Gastroenterol. 2010; 44: 354-360.

Key words: clostridial infections, patient safety, patient isolation, preventive actions, the role of nurses in prevention.

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робоче навантаження, що може вплинути на сприйняття медсестрами безпеки пацієнтів і їх здатність концентрувати свої зусилля на дотриманні правильних рекомендацій щодо запобігання передачі інфекції. Ми також наголошуємо вирішальну роль медсестер в підвищенні безпеки пацієнтів через їх постійну присутність біля ліжка хворого. Медсестри знайомі з щоденним клінічним станом пацієнта, тому вони можуть бути ефективно залучені і допомогти в зменшенні випадків клостридіальної інфекції в лікарні.

Ключові слова: клостридіальна інфекція, безпека пацієнтів, ізоляція пацієнта, профілактичні заходи, роль медсестер в профілактиці.

По результатам аналізу наукової літератури установлено, що клостридіальні інфекції (CDI) в наступне время стають сержьою проблемою здоров'я на всій території світу від росту захворюваності і смертності, і в тому ж віріші і є самаю розповсюдженою причиною виникнення діарейних захворювань у госпіталізованих пацієнтів. По міру росту заборожаності збільшуються фінансові затрати на здоров'я.

В цій роботі ми вивчаємо профілактичні заходи, які включають ізоляцію контактів, гігіену рук і організацію/координацію сестринського уходу і отделень. Профілактичні заходи займають значну частину часу, і значно збільшують обов'язки медсестр безпеки пацієнтів і їх здатність концентрувати свої ефективності на дотриманні правильних рекомендацій по запобіганню передачі інфекції. Ми також подкріплюємо рівень медсестер в підвищенні безпеки пацієнтів, які в реальному часі безпеки пацієнтів, що веде до зменшення випадків клостридіальних інфекцій в лікарні.

Ключові слова: клостридіальні інфекції, безпека пацієнтів, ізоляція пацієнта, профілактичні заходи, роль медсестер в профілактиці.

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