Infectious diseases as complications following spinal cord injury

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Abstract

Background. Infectious complications in spinal cord injury (SCI) patients can increase the mortality and morbidity of the patients. The inability to do daily activity is the main cause of the occurrence of infectious complications. Good understanding and high awareness are needed to notice some infectious complications which are difficult to be diagnosed.

Methods. This paper is a literature review which was done by reviewing and searching journals with “infectious complication”, “spinal cord injury”, “infection” on the search engines. The authors found 52 articles are suitable to be composed as references for this paper.

Results. Several infectious complications may occur following the incidence of SCI and have a lot of disadvantages. The causes of these infections are multifactorial. Urinary tract infection, infected pressure ulcer, pneumonia, and some other infectious diseases may appear as complications. Extra care in hygiene and sanitation is needed, besides, high awareness is needed to discover these complications.

Conclusion. Monitoring post-SCI complications are complex and difficult. A high level of suspicion should be raised with frequent aseptic actions and procedures. Appropriate management including non-surgical or surgical procedures can be chosen to achieve the best outcomes. Early diagnosis and management are critical for the best treatment results.

Keywords: *Infectious complication, Spinal cord injury, Infection*

Introduction

Spinal cord injury (SCI) is a complex and life-disrupting medical condition that was mostly associated with multiple traumas.^{1,2} There are distinctive data about the incidence of SCI all around the world, however, the study reported that 12.000 new cases are noted annually.^{3,4} SCI could be happened due to injuries of any level of the spinal cord resulting in irreversible or reversible casualties.⁴ The functional outcomes of SCI patients usually depend on the completeness disruption level of the spinal cord.⁵ Patients with SCI usually need some more time to stay in the hospital following their needs of treatment and rehabilitation. This prolonged stay in the hospital may lead to an increased risk of developing infectious complications.^{6,7} Not only do infectious complications hold a bigger risk of morbidity and mortality but also precipitate higher cost of management.⁸

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SCI patients may acquire complications through several factors. Constant usage of invasive medical devices including urinary and intravascular catheters may cause community-acquired infections.^{6,9} Besides, incompetence to cough, changing position, walk, sit, and some other risk factors may contribute to predisposition in a different type of infectious complications. A high morbidity burden is produced by this complication apart from death. The most common infectious complications are systemic infections including respiratory tract infection, urinary tract infection, bloodstream infection, etc.¹⁰ The inability to move, sit, and change position may cause pressure ulcers and skin infections, osteomyelitis may also occur.¹¹ Other infection, such as pneumonia, often occurs to many individuals with SCI need intubation with a mechanical ventilator. The usage of a prolonged mechanical ventilator in the intensive care unit may provoke the occurrence of ventilator-associated pneumonia.^{12,13}

Antibiotic therapy is should also be concerned as many cases nowadays with antimicrobial drug resistance cases. Thus, the management of the post-SCI patient is challenging.¹⁴ Adequate antimicrobial therapy is important as it may control the ongoing infection.¹⁵ Few drug-resistant microorganisms, such as methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, *Acinetobacter*, and extended-spectrum β -lactamase (ESBL)-producing *Enterobacteriaceae* especially in developing countries are needed to treat with appropriate antimicrobial choice for the reason of overcoming dreadful adverse outcomes. Initial antibiotic treatment for the first 24 hours is crucial.^{14,15}

Many complications can happen following the SCI. One of the most important and often happens is infection. Infection complications themselves are varied. Multiple system organs could be affected by this complication since many factors may play a role in the process. Clinicians need to know this complication following individuals with SCI history. It is also essential for clinicians to have the ability to calculate and predict infection being one cause of increased morbidity and mortality. Good understanding and brief awareness about the complications are needed. Hence, this paper is made to explain the infectious complications in post-SCI individuals to gain more insight into these problems.

Mechanism of Infection in post-SCI individuals

Multiple organs might be affected following the injury. The occurrence of complications can be short and long-term throughout the whole body. Multifactorial aspects may contribute to infectious complications.¹⁶ There are many pro-inflammatory mediators released

in the local inflammatory microenvironment following the accumulation of degenerated neurons, myelin sheath, damaged endothelial cells, stimulated glial, and infiltrating cells. This intraspinal inflammation can trigger a life-threatening situation called systemic inflammatory response syndrome (SIRS).¹⁷⁻¹⁹ The whole process of post-injury can cause another emanation in the immune interplay with the spinal cord.²⁰ SCI-induced immune depression syndrome (SCI-IDS) is a major factor causing the complication, this phenomenon happens because of the sympathetic nervous system dysregulation and immune organ flawed.²¹ The disruption of supraspinal control over the hypothalamic-pituitary-adrenal axis is occurring in thoracolumbar spinal cord projections to sympathetic ganglion because of SCI. The progress is resulting in sympathetic nervous system dysfunction.^{22,23} Not only does SCI-IDS worsen the neurological function but also diminish the circulating immune response including both innate and adaptive immune response in rats with SCI.²⁴ There was a pilot study conducted with 16 SCI patients that showed a lower level of monocytes, T lymphocytes, and B lymphocytes without decreasing the level of granulocytes in 24 hours post-injury.²⁵

Several organs related to infection might be affected such as the lung, spleen, urinary system.²⁶ The exact theory behind this immune-depression is still unknown, however, there is a theory that the injury causes interplay trouble between the immune system and CNS. A great number of inflammation mediators in several activations including the hypothalamus-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS). The process in the HPA axis may include glucocorticoids resulting in a natural killer cell (NK cell) or antigen-presenting cell (APC), these mechanisms may cause impairment in antimicrobial defense as APC induces the release of an inflammatory mediator. SNS pathway induction may be causing the great amount of catecholamines release as it may induce type 1 T-helper cells and NK cells resulting in the interferon- γ and apoptosis activity. These are causing impairment in anti-inflammatory response through the abundant amounts of glucocorticoids and catecholamines release.^{22,23,27} Anti-inflammatory impairment is resulting in an increased risk of infection as the function of antimicrobial defense is impaired. Loss of neurological function also takes part since the loss of protective reflexes precipitating dysphagia, aspiration, bladder dysfunction, and invasive medical procedures enhance the bigger risk of infection.²⁷ There is another hypothesis describing the potential of efferent vagus nerve fibers, provoking the delivery of acetylcholine. Also, it may inhibit the activity of macrophage by competitively attaching to specific nicotinic acetylcholine receptors.²⁷

Infectious complications following SCI

Urinary tract infection (UTI)

Impaired supraspinal control in the urinary system may affect the bladder and result in a neurogenic bladder. The condition may lead to in patient's inability to emptying the bladder.^{28,29} Paraplegia due to SCI also contributes to the disease. Multifactorial reasons are accountable, such as a curtailed sensation of classical UTI symptoms, incomplete bladder emptying, frequent catheterizations, or chronic urinary tract catheters.³⁰ Becoming the second leading cause of death in SCI individuals, clinicians should be aware of this complication. UTI cause serious complication following the UTI progression to sepsis and septic shock if left undiagnosed and untreated.^{28,29,31}

Due to the difficulty in detecting early symptoms, all relevant conditions should be evaluated before a fever develops in UTI.³² The longer usage of a foley catheter should also be a concern in developing UTI. Biofilm of bacteria may cause cystitis and 80% of UTIs are because of the catheter application. Compared to short-term catheterization, the long-term catheter has a higher risk of infection, additionally nitrofurazone-coated and the silver alloy-coated catheter can reduce the risk of infection in the short-term usage of a catheter.³³ UTI in individuals with SCI are also followed by several risk factors, such as reflux of vesicoureteral, postvoiding residuals, outlet obstruction, urinary tract stones, and bladder overdistension.³⁴

Colonization of resistant organisms because of prolonged hospital stay held a new challenge as the treatment of these UTI patients may be difficult. Hence, making sure the catheter in a closed condition is crucial so that no organisms can enter the system. The duration of the catheter is also critical, periodic catheter and suprapubic catheter could be used as a replacement for an indwelling catheter to reduce the risk of infection.³⁵ Early recognition and extra attention should be taken by the clinician in case of this infectious complication. Evaluating the hygiene of the urinary tract is necessary including the evaluation of functional and structural disorders. Antibiotic prophylaxis is recommended to be given immediately before applying any invasive medical devices.³⁶

Pressure ulcer

An infected pressure ulcer is a frequent infectious complication in SCI individuals.¹¹ This complication is serious and important as it cause long-term morbidity and can affect quality of life, even causing mortality.³⁷ This chronic lesion attenuates SCI patients and prolongs the hospital's course. The prevalence among hospitals regarding infected pressure ulcers varies from 25% to 66%.³⁸ Multiple

organisms can be found in the ulcer, including aerobic and anaerobic microorganisms. The condition of necrotic tissue with the addition of a certain smell has been defined as anaerobic isolation in the deep tissue. The most common predilection sites are ischial tuberosity, the trochanter, and the sacrum which commonly form on the bony prominence.^{11,39} There are many risk factors in the contribution of pressure ulcers such as cervical collar and spinal board causing confined activity, paralysis due to complete cord injury, history of smoking, diabetes mellitus, hypoalbuminemia, nursing home residence, or prolonged hospital stay. Besides, sensation loss, wet areas due to fecal or urinary incontinence, poor nutrition, and muscular atrophy are also contributing to risk factors of pressure ulcers.⁴⁰ Some soft tissue or skin infections may also infect SCI patient, including seborrheic dermatitis and fungal infections.⁴¹

The management can be done by relieving the pressure and doing wound debridement. Antibiotics can be given if wound infection or bacteremia is found.³⁹ To prevent this complication, frequently changing position is important followed by using the pressure-relieving device, and regular observation of the skin which is on the bony prominence area.^{38,39} Tissue oxygenation is also an important factor regarding it's important to boost the pressure resistance of the patients. Hand hygiene, contact precautions, and cultural changes are important activities that decreasing the significant number of bacterial infections, notably MRSA and other infections.³⁸

Pneumonia

Several pulmonary complications can occur throughout SCI, including atelectasis, pneumonia, chest injury, and other respiratory failures or an infection are accountable in causing morbidity and mortality.⁴² Respiratory complications involved in SCI are complex. It includes lung inflammation, vascular impairment, and even still developing an infection. The progress of pneumonia itself may develop shortly after or even in the rehabilitation stage which most of pneumonia occurs.^{43,44} One of the major reasons that pneumonia can occur is because of the inability in doing effective cough.^{10,42} Additional phrenic and intercostal nerve damage may also contribute. The post-intubation patient that is attached to a ventilator has a great risk of developing ventilator-associated pneumonia (VAP) and prolong the hospital stay. Antibiotic treatment based on the endotracheal culture is important to choose empiric treatment.^{10,12,42}

Lung volume scaled down in the SCI patients with higher levels of inflammation markers IL-6 and C-reactive protein (CRP).⁴⁵ Production of proinflammatory mediators and pulmonary infiltration

can be reduced by the administration of pharmaceuticals. Furthermore, it may also diminish systemic inflammation and debilitate the risk of pulmonary dysfunction. Administering anti-inflammatory is proven to be critical as it may decrease inflammation, thus, it also accelerates the recovery of pulmonary function in SCI patients.⁴⁶

Retained secretion because of ineffective cough is the most important risk factor. Some methods can be used to handle and prevent this inability, including pulmonary toilet, proper positioning, and cough assistant (frequent suctioning). Extra awareness in oral care is important with the addition of frequent cleaning of the ventilator to diminish the risk of VAP.^{42,47}

Bloodstream and other infections

Bloodstream infection is secondary to other infections, usually urinary, pneumonia, and pressure ulcer.⁹ Several factors decide the outcome of bloodstream infection such as the site of infection, species involved, drug-resistant organisms, and independent factors. Statistically, inadequate therapy in bloodstream infection is not causing any difference in mortality rate.⁴⁸ However, it is still important to administer appropriate antibiotics as this may prolong hospital stay and escalate the costs.^{14,15,39}

Osteomyelitis occurrence could happen as the complication of pressure ulcer or spinal surgery. Osteomyelitis can lead to other complications and also raise the cost of the treatments.⁴⁹ Several methods can be chosen to diagnose osteomyelitis, from bone biopsy as the gold standard to MRI which giving high sensitivity and specificity, or even with additional serum investigation (CRP, ESR, PCT).^{50,51} Bone scan also can be used to eliminate osteomyelitis.⁵¹ Treating osteomyelitis is divided into surgical and non-surgical management. The combination of these two is essential in shortening the duration of the management.⁴⁹ To prevent osteomyelitis, it is important to monitor the source of infection, pressure ulcer should be monitored carefully. If available, hyperbaric oxygen therapy can be used to treat chronic refractory osteomyelitis.^{49,52}

Again, immune suppression in post-SCI individuals plays a major role in causing infections.^{21,27} Any usage of blood products, surgical procedures, and injection sites should be taken care of in hygiene. Meningitis may also occur as the result of CSF leakage at the injury scene or post-injury. Acute abdominal emergencies such as gastrointestinal bleeding, peptic ulcer perforation, and pancreatitis are often missed since the loss of sensation circumstances.⁸

Conclusion

Monitoring post-SCI complications are complex and difficult. Infectious complications have many disadvantages as those could increase morbidity and mortality rates. Immune suppression is hypothesized as one of the main reasons contributing to the incident of infection post-SCI. Not only do infectious complications cause prolonged management but also increases the cost of treatment. Infectious disease as the complication of SCI is important to be noted and should be monitored with a high level of suspicion. Early diagnosis with the addition of appropriate treatment, including non-surgical and surgical interventions, good sanitation and hygiene are important and can be life-saving prevention to decrease morbidity and mortality.

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