



Cervical spine pathology and treatment: a global overview

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Abstract: Cervical spine pathology is becoming increasingly prevalent with an aging world population and is associated with significant morbidity, affecting all areas of the world. This review was undertaken to provide a global perspective on cervical spine pathology, including epidemiology, burden of disease, access to care, and plan of care in both developed and developing low- and middle-income countries (LMICs). We found that epidemiology, access to care, plan of care, and health outcomes were relatively similar between nations with similar economies. However, these aspects change dramatically when comparing developing nations to LMICs, with LMICs displaying substantial barriers to care and subsequently higher rates of morbidity and mortality. There is currently a need for large-scale, global, prospective multicenter studies that analyze not only the epidemiology and treatment of cervical spine pathology, but also consider patient outcomes.

Keywords: Cervical spine pathology; global overview; spine surgery; epidemiology; low- and middle-income countries (LMICs)

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Global burden of cervical spine pathology

Cervical spine pathology is becoming increasingly prevalent with an aging world population and is associated with significant morbidity, affecting all areas of the world (1). The World Health Organization has projected that the proportion of the population older than 60 years is to double from 11% in 2010 to 22% in 2050—an epidemiological transition reflecting the evolution from infectious diseases to chronic, degenerative diseases (2,3). This is posing a global health risk, particularly in developing countries, as individuals in this age group face high rates of symptomatic cervical pathology (3). Cervical

spine surgery (CSS) improves outcomes in select patients with cervical spine pathology (4). Advancements in surgical techniques and technology have led to lower morbidity and mortality rates and reductions in long term neurological symptoms (5-7). While the last two decades have seen a rise in successful evidence-based treatment modalities, multiple additional factors continue to influence these surgical outcomes, such as quality of emergency treatment at the time of trauma, amount of time elapsed prior to treatment, type of intervention, and the overall quality of the healthcare system (8). Many regions of the world still lack the resources and adequate funding to provide safe medical care for patients with symptomatic cervical pathology (9).

Additionally, there is a large gap between the medical care available for patients in developing countries compared to developed countries. Thus, it is imperative to have a global perspective of cervical pathology and cervical spine surgery, so that global strategies can be formulated to improve care in regions with more limited resources.

This article provides an overview of the epidemiology, demographics, and management strategies of cervical spine pathologies in different regions of the world. This study aims to: (I) summarize the epidemiology and burden of cervical pathology in different regions of the world and analyze the notable differences between them; (II) examine the prevalence of spinal disorders in rural populations in low- and middle-income countries (LMICs); (III) analyze and compare the various pathways/approaches utilized globally in the care, management, and treatment of cervical pathology including variations in CSS interventions as well as patient outcomes based on the type of care and procedure; (IV) summarize treatment strategies for cervical spine interventions.

Methods

A literature search was conducted on the PubMed, Embase and Cochrane Library databases with a focus on cervical spine pathology, epidemiology, and treatment and intervention modalities. This literature review reports on 64 manuscripts from fourteen countries across four continents. Fourteen manuscripts reported on North America, 8 from Europe, 21 from Africa, and 21 from Asia. The majority of the studies conducted were either a retrospective or prospective analysis on cervical spine disease. Countries (n=13) were classified based on income using recent [2019] World Bank income classification data and were designated a high-income country (n=4), upper-middle-income country (n=1), and lower-middle-income country (n=8).

Epidemiology and burden of cervical spine disease

United States

The United States is a developed country with high median income and a large, urban population that largely has direct access to readily available, quality healthcare services. With a well-established medical education system, research and funding, the United States is at the forefront in medical research and patient care with advanced

technology. However, like the rest of the world, the United States is facing a new demographic issue—aging. This “epidemiological shift” in the United States has resulted in the rise of cervical degenerative diseases and a shift from infection-based pathology (10). It was seen in 2014 that of all spinal cord injuries/disease, 54% were degenerative and this is rapidly increasing (11).

While the United States is one of the most advanced nations in the world, its aging population (65 years of age or older) has resulted in one of the highest global prevalence of degenerative cervical spine pathology. Assessing the incidence of cervical spine degeneration, a retrospective study (n=3,156,215) conducted between 2006 and 2012, found an increase in the annual incidence of the disease by about 1.0 per 1,000 patient diagnoses (12). In 2018 alone, nearly 54.4% of all injuries were of the cervical region during the time of discharge (13). In addition, cervical degenerative diagnosis increased nearly 42% between 2008 and 2014, due to improvements in various imaging modalities, technological advancements and an enhanced understanding of biomechanics (12). The incidence of cervical spondylotic myelopathy is also on the rise, with cervical degenerative disease, ossification of the posterior longitudinal ligament, and ossification of the ligamentum flavum, being the most common (11).

Analyzing cervical traumatic spinal cord injuries (tSCIs), a 2015 study showed that overall tSCI resulted from motor vehicle crashes (39.3%), followed by falls (31.8%) and then violence (13.5%) (14–16). Of note, tSCI was once considered a disease of young men in high velocity motor vehicle accidents. However, recent trends suggest that cervical tSCI is increasing in elderly patients who are involved in low velocity accidents (16).

Burden

It is estimated that by 2050, nearly 20–22% of the population of the United States will be the age of 65 or above compared to only about 16–17% in 2019 (17). This suggests there will continue to be a rising prevalence of degenerative cervical spine disorders due to growing numbers in the at-risk population group. High costs for medical treatment and surgical procedures add to the growing burden. An epidemiological, retrospective study (n=18,386) which analyzed the trends and costs of anterior cervical discectomy and fusion procedure costs between 2007 and 2014 showed that there was an overall decrease in the costs for inpatient and outpatient care per person even though trends have shown an increase in the demand for

both (18). Regardless of the cost, outcomes of surgery are generally very good. A retrospective study examined a large number of cervical spine procedures performed between 2003 to 2012 (n=342,477), and calculated the mortality rate to be 0.32% overall (19).

China

China is the world's most populous country with one of the fastest developing economies. Within the last two decades, China has made great strides in their healthcare system with a high life-expectancy and increasing healthcare quality. China has also become primarily an urban hub with a growing youth population. However, China is also facing a great dilemma as the population of the elderly is expected to rise drastically with a dependency ratio that is projected to rise for the next few decades (20,21). With rapid economic and population growth, China has seen an increase in overall cervical spinal pathology. Between 2003 and 2011, there has been nearly a 7% growth in the proportion of patients with spinal pathology, of which nearly 55% to 75% of all cases were involving the cervical spine (20). The prevalence of degenerative cervical spine disease was found to be the highest in one retrospective cohort-based study, reporting that nearly 49.6% of the patients had some type of cervical degenerative disease, of which 32.74% fell within the 41–65 age range (22). Of the different types of cervical degenerative disease, cervical spondylosis and cervical myelopathy were of interest in some studies. In a community based cross-sectional study (n=3,859), the prevalence of cervical spondylosis was 13.76%, with individuals between 45 to 60 years of age showing the highest rate (21).

The rate of tSCI has also been on the rise with an annual reported incidence rate of 65 per 100,000 hospital admissions with an average age of 42.5 years of age. In a retrospective study (n=643), the leading cause for cervical spine trauma was motor vehicle accidents (33.1%) followed by falls from a high height (32.8%) (23).

Burden

In 2016, it was estimated that 11.40% of the Chinese population was 65 years of age or over (21). This large percentage of an aging population paired with an already high prevalence and growing incidence rates of cervical spine disease highlights the potential financial and healthcare burden of this disease. In addition to cost, the increase in potential patients will strain the already

overwhelming surgical case load, as the rate of surgical procedures has already increased by 300% since 2004. According to a 2011 population census, 2.75 million patients suffered from cervical spondylosis in Beijing alone, which represents 13.75% of the over 20 million population (21). This fact underpins the already strained healthcare system and the potential burden the future carries.

South Africa

South Africa is a developing, middle-income country which has in recent times, seen stagnation in government spending in the health care sector in recent years. Health spending takes on about 13.5% of the nation's expenditure which is well below its commitment of 15% (24). While having a developed economy, South Africa has been ravaged by an increased number of spinal tuberculosis (Pott's disease) cases, low health-provider regulation, and increased violence, all of which have collectively affected the epidemiology of cervical spine diseases in this nation (25). South Africa has a relatively higher prevalence of traumatic cervical spinal cord injury than degenerative disease. Largely due to a young population (mean age of 27.1 years of age), degenerative cervical spinal conditions are far less studied due to their lower prevalence in this nation. On the other hand, traumatic injury is largely linked to violence and assault and has been well studied. In a prospective study (n=145), the prevalence of spinal cord injuries, in general, has estimated to be 75.6 per million (26). This is largely due to assault (59.3%) followed by motor vehicle accidents (26.3%). It was seen that nearly 53.1% of all injuries occurred in the cervical spine. In another retrospective study conducted at a tertiary hospital in Cape Town (n=346), 29% of all cases involved cervical pathology, of which, 31% was degenerative and 47% was traumatic (27).

Burden

The cost of cervical spine surgery is quite high relative to the mean annual income in South Africa. This may be due to the fact that spinal surgery typically lasts longer due to the complexity of the injury and the nature of the procedures (28). It is estimated that cases that average about 7 hours can have a cost in Rand (South African Currency) R72,000 per case, or about \$5,000 (USD). This cost is quite enormous considering the relative poverty of the people. Pairing this with the fact that procedures have a relatively high mortality rate suggests the need for greater investment of resources within the spine pathology sector (27).

Japan

Japan is an advanced and developed nation with the world's third largest economy. The Japanese government has made it a priority to provide near universal, quality healthcare with an emphasis on elderly care. This is due to Japan's huge elderly population which is growing dramatically every year (29). With a decreasing workforce and an aging population, both Japan's economy and healthcare system are facing potential long-term issues.

Degenerative cervical spinal issues have been on the rise in Japan and have notably affected the elderly population. A retrospective analysis (n=1,155) looking at cervical myelopathy cases found that most patients were between 60 to 70 years of age, with the annual operation rate of about 16.5 per 100,000 people (30). Analyzing the types of cervical diseases, 40% of the patients had developmental stenosis, 48% had dynamic stenosis, 27% had a disc herniation and 11%, segmental ossification of the posterior longitudinal ligament. Multiple studies have noted the growing concern of ossification of posterior longitudinal ligament in the cervical spine in this population (17). One longitudinal observational study (n=1,291) calculated the overall prevalence of ossification of posterior longitudinal ligament in participants at 3.7% with trends showing a higher prevalence in males between 60 to 69 years of age (31). In another retrospective study (n=127), degenerative changes of the cervical spine were seen in 90% of patients (32). This included cervical spondylosis (52%) and ossification of posterior longitudinal ligaments (38%).

tSCIs in Japan have been reported to have an incidence rate of 40.2 per million (33). A retrospective study (n=127) analyzing cervical cord injury noted that the major mechanism for injury in younger patients (<46 years) was motor vehicle accidents (39%), while falls accounted for nearly (42%), with falls being more prominent in older patients (32). The average age of all patients with TSCI was 60.4 years. In addition, a quarter of the falls were on level ground, highlighting the effect of an aging population on the overall etiology of spinal cord injuries (32,33).

Burden

The aging population in Japan is placing a great strain on the Japanese healthcare system, evidenced by the increasing rates of cervical and spinal cord injuries. In 2014, a population census estimated that 33.0% of the Japanese population is above the age of 60, and people aged 65 and older in Japan make up a quarter of its total population (29).

Projections have estimated that this group will represent a third of the overall population by 2050. Efforts have been made to alleviate healthcare burdens through the universal healthcare coverage system, which comes from 5% of an individual's overall income (34).

Norway

Norway is a prosperous, developed nation boasting one of the world's highest standards of living. A high GDP, universal healthcare coverage, and high physician density has contributed to high satisfaction of living and advanced healthcare system in the country. Like many other European nations, Norway is facing an aging population (35). However, Norway benefits from high fertility rates and net immigration which lowers its old-age ratios (35,36). Easy accessibility to quality education, with an emphasis on individual wellness, along with high employment rates has allowed Norway to improve patient outcomes for those with degenerative and/or traumatic spine diseases (35,36).

Degenerative cervical spine diseases have been on the rise in Norway largely due to its aging population. A random sample study (n=10,000) reported that 34.4% of the participants experienced neck symptoms that had lasted for more than 1 month, pointing to the risk that degenerative cervical spine diseases pose to the population (37). A population-based study (n=6,511) found a 74.1% increase in annual surgical rates for degenerative cervical spine diseases between 2008 and 2014, suggesting a growing incidence and prevalence of cervical degenerative diseases themselves (38). Surgical treatment for radiculopathy and cervical myelopathy increased by 86.5% and 44.6%, respectively. The mean age for patients with radiculopathy and cervical myelopathy was 52.2 years for men and 50.8 years for women.

Traumatic cervical spinal cord injuries have been on the rise in Norway largely due to its aging population. A cross-sectional study with retrospective data (n=387) calculated the annual incidence of traumatic cervical spinal fractures to be 11.8 per 100,000 in Southeast Norway (39). The median age for patients with TSCI was 54 years with 69% of patients being male. Overall, it is estimated that the annual incidence of surgery for TSCI in the Norwegian population is 3.0 per 100,000 (39). A prospective population study (n=319) found that the primary trauma mechanism was falling (60%) followed by motor vehicle accidents (21%) (40).

Burden

The burden of cervical spinal cord disease has largely

been muted in Norway due to the nation's commitment to developing advanced and affordable medical care for its citizens. Surgical procedures on degenerative cervical spine disease have been reported to have a nearly 0% mortality rate at one outpatient facility with 99.8% of patients being successfully discharged on the day of surgery with an overall complication rate of 3.5% (41).

LMICs

Spinal disorders are a major cause of disability, economic hardship, and morbidity worldwide (42–44). However, recent research suggests that the prevalence and mortality of spinal disorders are of increasing concern in rural and medically underserved areas in LMICs (45). Risk and prognostic factors for spinal disorders vary greatly between high-income and low-income countries, with lower-income countries typically experiencing higher levels of risk and burden (46,47). Furthermore, vulnerability to spinal disorders, including their associated comorbidities, is often greater in LMICs than high-income countries. Inadequate access and availability of healthcare resources were found to contribute significantly to substandard outcomes and increased mortality rates in patients with spinal cord injuries in LMICs (48–50).

A ten-year multicenter study in southeast Nigeria found that the cervical spine was the most commonly injured segment and associated with a higher mortality rate (16.7%) than compared to those reported in high-income or developed countries. This was due to the lack of emergency medical services, critical care facilities, as well as the greater overall incidence of high cervical injuries (48). Furthermore, a study conducted in Nepal examining the prevalence of spine radiculopathy and myelopathy found that a remarkable 58% (69 out of 119) of the patients suffered from cervical spondylosis, suggesting a rather increasing rate of degenerative disease in the Nepalese population (49). A study examining six rural districts in the Kilimanjaro region of northeast Tanzania found that the cervical spine region had the highest incidence (38%) and mortality (45.8%) rates for all patients presenting with spinal cord injury (51). Additionally, a prospective multicenter study conducted in India—an advanced country, yet in which nearly three quarters of the country's population is rural—found that injuries in the lumbar were the most common (51.0%), followed by thoracic (30.7%) and cervical (18.2%) (52). The study also analyzed patient outcomes and found that the 30-day complication and mortality rates were 10.0%

and 2.6%, respectively. Furthermore, the first COPCARD (Community-Oriented Program for Control of Rheumatic Disease) study in India examining the prevalence of rheumatic disease in a rural population (Bhigwan district) found that 11.9% and 6.5% of the population indicated that they had been affected by lower back pain and neck pain, respectively (53). A similar COPCARD study in a rural community in Bangladesh reported higher rates of back pain: 20.1% for lower back pain, and 10.8% for neck pain (54,55).

Barriers to care and poor outcomes in low and middle-income countries

In resource rich countries, the majority of patients survive their first year of post spinal cord injury (SCI). However, there is a large discrepancy in observed mortality between resource rich and resource poor countries (56). In one study of 24 subjects who suffered a SCI from Sierra Leone—a LMIC in West Africa—7 individuals died during initial hospitalization, 8 individuals had died at follow up (average 17.4 months) and 4 were lost to follow-up (57). Furthermore, an article published by the World Health Organization (WHO) concluded that more than 90% of the deaths that result from injury worldwide (irrespective of etiology) occur in LMICs, with mortality rates and financial burdens being significantly higher in LMICs than compared to high-income countries (58). Additionally, in high-income countries, life expectancy for persons with SCI has increased dramatically due to enhancements in medicine, prevention and treatment, including early acute management and long-term rehabilitation. However, in rural areas in LMICs, poverty, compounded by lack of medical resources, access to healthcare, and post-injury complications, to name a few, have all contributed to the decreased life expectancy of SCI patients in such areas (59). Many of these complications have been attributed to poor public healthcare services in rural areas, which were notable for being understaffed, overcrowded, and inadequately resourced. In India alone, one study found that being treated at a public hospital was an independent predictor of significant mortality, reoperation, and complications following spinal trauma. The study found that the odds of incurring major health complications for patients treated for spinal trauma at a public hospital was 6.7 times (95% CI =1.1–4.6) the odds of incurring a major complication for patients treated at a private hospital (59). When analyzing major post-operative complications, we found that pressure ulcers, UTI, and

septicemia were the most common complications and causes of premature death in patients with SCI in LMICs (51,56,57,60,61). Unfortunately, complications such as pressure ulcers could have been prevented with access to basic post-operative resources. A study conducted in Zimbabwe found that from among the 19 patients who were discharged following SCI, 18 had died due to pressure ulcers. Only one had survived, and according to her, that was in large part due to her simply having access to a wheelchair, a basic resource that was not given to the other 18 patients (60).

A notable factor that may contribute to poor clinical outcomes in patients suffering from SCI in LMICs is the lack of resources available to deliver timely acute care to SCI patients. In many low-resource regions, it is uncommon for an individual with an acute SCI to be immobilized in the field and transported by trained personnel, such as an ambulance or a paramedic team. In the setting of an unstable spine, this can lead to further neurological compromise (56). In one study of 83 subjects from Pakistan, none of the subjects were immobilized at the accident site and only 18 were transported by ambulance (50). Furthermore, delays are quite common between the time of initial injury to the time of presentation for specialized care, which also may contribute to poorer outcomes and additional complications. One study from India found an average 45 days (range, 0–188 days) delay between the initial injury and presentation to a spinal care unit (62). A more recent 2017 prospective study in India found that more than 1 in 5 patients (21.6%) experienced a delay in receiving spinal care (52). In the Sierra Leone study, five out of the seven patients who died in hospital had been referred from other hospitals with an average delay of 17 days (range, 3–42 days) post-injury (56,58).

Despite the research indicating that spinal disorders, in general, are of increasing concern in LMICs, it is also important to note that patients with cervical SCI are far less likely to survive than compared to patients suffering from injuries related to the thoracic or lumbar regions (51,56). Although cervical, thoracic, and lumbar injuries collectively have poorer first year survival rates than those with similar injuries in developed countries, individuals with cervical SCI are even less likely to survive the initial injury and/or hospitalization in developing and resource poor regions (56,63,64). Hence, it is imperative to evaluate current treatment modalities and plans of care to help determine effective approaches to improve the overall outcomes for cervical spine disease in these regions.

Global treatment strategies for cervical spine pathology

United States

Treatment for both degenerative and traumatic cervical spine injuries in the United States is composed of surgery and/or medication (12,14,65). A retrospective review (n=757) found that surgical management was more prevalent with increasing age (58.8% for <35 years of age, 73.7% for 35–64 years of age, 82.1% for 65 years of age or older) (14). In the absence of frank neurologic deficit, treatment always begins with a conservative approach consisting of activity modification, physical therapy, non-steroidal anti-inflammatory medications, and injections. Surgical treatment on the cervical spine for fractures or myelopathy include, but are not limited to, anterior cervical discectomy and fusion, cervical disc replacement, anterior cervical corpectomy, laminoplasty, and posterior cervical decompression and fusion (66). Studies have suggested that both anterior and posterior surgery has similar outcomes but different complication profiles for multilevel cervical spondylotic myelopathy (11,18,66,67). In addition, the recovery rates between anterior and posterior surgery differ significantly (18,19). In a retrospective study (n=1,420), patients with cervical radiculopathy and degenerative disk disease underwent surgical procedures primarily with anterior cervical discectomy and fusion (50%). The second most common procedure was an anterior cervical corpectomy and fusion (28%) followed by posterior cervical decompression +/- fusion (19%). The least common, but increasing, procedures reported were anterior cervical discectomy and arthroplasty (3.1%) (68).

China

Treatment options consist primarily of surgery in symptomatic patients, which has been reported to have a high success rate due to reduced timing between the time of injury/diagnosis and procedure (21,22,69). However, a retrospective analysis (n=1,163) witnessed a 9.4% early mortality rate in patients with high cervical injuries (C1–C3) (69). Cervical spondylotic myelopathy has been shown to be safely treated through surgery from either the anterior, posterior, or a combined anterior and posterior approach. It has been suggested that anterior approach leads to lower complication rates, postoperative adverse reactions, and improves postoperative neurological function compared to the posterior, or combined anterior-posterior approaches (70).

Even with advancements in various techniques and technology, China still faces a prodigious task of caring for an aging population.

South Africa

Treatment for spine disease in South Africa is consistent with many other nations, consisting of either surgical or non-surgical procedures. A study assessing the outcomes of cervical spine injury surgery (n=101) found that only 31 cases were managed conservatively, while the rest underwent anterior decompression and plating (n=55), anterior Dens screw fixation (n=5), laminectomy (n=3), or posterior fusions (n=7) (28). The overall mortality rate of all the procedures performed was 13.86%. The study observed a significantly higher mortality rate at 33% in patients with high cervical injury (C1–C4). Patients with tuberculosis were given anti-tuberculous treatment such as rifampin, isoniazid, and pyrazinamide (71). Studies have shown that 82% to 95% of patients with spinal tuberculosis responded very well. Even with treatment options, the burden cervical spine injury has placed on the population is increasing and reveals the need for reforms in the healthcare sector (71).

Japan

According to the Japanese government, healthcare coverage is universal and a requirement for all Japanese citizens. In addition, the Japanese healthcare system does not have general practitioners, thus allowing patients to seek immediate attention to their healthcare needs. The healthcare system allows patients to have multiple treatment options for cervical spine diseases. In a retrospective analysis (n=1,155) looking at degenerative cervical myelopathy surgical trends, anterior and posterior decompression were common treatment options that were equally chosen between patients (30). However, cervical laminoplasty was far more predominant than cervical laminectomy (72).

Norway

Treatment for cervical spine diseases in Norway is composed of both surgical and non-surgical procedures with a growing demand placed more on surgical procedures. A prospective, single-center study (n=1,449) noted that there has been an increased demand for surgical treatment of degenerative cervical spine diseases due to the aging population and increased public awareness of the positive

clinical outcomes of surgery (41). Another population-based study (n=6,511) calculated that surgical rates for cervical degenerative diseases increased by 74.1% between 2008 and 2014; surgical treatment for both cervical myelopathy and radiculopathy has shown the greatest increase (38). In Norway, anterior cervical discectomy, anterior cervical decompression and fusion are the most common treatment methods for degenerative cervical spine diseases (41,73). Patients who displayed severe root stenosis underwent microsurgical posterior cervical foraminotomy. A recent prospective multi-center study (n=136) on Norwegian patients has suggested the benefits of using cervical arthroplasty as a treatment modality due to excellent clinical results (73). A cross-sectional retrospective study (n=387) analyzing treatment methods for traumatic cervical spine diseases found that only 18% of patients opted for open surgery, suggesting that conservative and/or non-surgical methods were preferred (39).

Conclusions

In summary, the prevalence of cervical pathology is increasing across the globe regardless of economic status. Aging populations are greatly influencing the epidemiology of cervical pathology in upper and upper-middle income countries. This is the opposite of what has been observed in LMICs where epidemiology has been influenced by trauma, the lack of medical resources, general poverty, and poor patient care. It was observed that in developed countries where the patient population has easier access to healthcare and higher literacy rates, the life expectancy is generally higher, which helps explain the increase in aging population observed in developed countries. Thus, these patients generally have a greater likelihood of developing more degenerative disorders or spinal metastases. Conversely, patients in LMICs typically lack access to quality healthcare, face general poverty, have lower literacy rates, thus making them more susceptible to infections or trauma. Therefore, there can be an under and/or overrepresentation in disease trends, etiologies and distribution of various cervical spinal pathologies. However, irrespective of the etiology, patients in LMICs face numerous barriers to cervical spinal healthcare, which has resulted in lower patient outcomes compared to developed nations. While the access to quality patient care varies depending on the type of nation, the general surgical care pathways remain quite similar. Overall, variations in patient outcomes globally have been attributed to availability (or lack thereof) of local healthcare facilities,

quality of healthcare facilities, and trained staff.

Future direction

There is a significant lack of robust studies on cervical spine pathology throughout the world. There is currently a need for large-scale, global, prospective multicenter studies that analyze not only the epidemiology of cervical spine pathology, but also consider specific types of spine pathology, treatment approaches, quality of care, and ultimately patient outcomes. The results of such a study will provide direction for future research and policy initiatives imperative to reduce the burden of cervical spine pathology and improve patient outcomes worldwide.

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Footnote

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