REVIEW ARTICLE

OSTEOPATHIC CONSIDERATIONS IN PNEUMONIA

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ABSTRACT:

Pneumonia contributed to nearly 3 million deaths worldwide in 2016 and 56,000 deaths in the United States alone in 2017, and as such, it is imperative for physicians to understand the causes, subtypes, associated risk factors and treatment options. This article will address each of these, as well as special consideration for the osteopathic approach to care.

INTRODUCTION

Pneumonia is a clinical condition commonly seen in medical practice. The purpose of this article is to review and expand on the reader's knowledge of the clinical problem, including its causes, subtypes, associated risk factors and treatment options. Special consideration is given to the osteopathic approach to the care of this population and the various models that inform this approach to treatment.

Pneumonia is defined as an infection of the pulmonary parenchyma that may cause a wide variety of signs and symptoms.[1] The lungs may fill with purulent material, causing shortness of breath, cough, fever and chills, depending on the organism causing the pathology. Variations among the types of pneumonia are numerous, and the ways to classify the pathology are diverse. Some potential ways to organize pneumonia pathology are by severity, bacterial vs. viral infection or the location of the disease's acquisition.

In this article, pneumonia is organized into subtypes based on where or how the patient acquired the disease. Pneumonia is classified into subtypes, including interstitial (walking) pneumonia, community-acquired pneumonia (CAP), hospital-acquired pneumonia (HAP, also known as nosocomial pneumonia) and aspiration pneumonia. Each subtype has its own range of symptoms and severity, and it is important to understand each subtype and the potential pathogens associated with it.

Epidemiology

With pneumonia contributing to roughly 3 million deaths worldwide in 2016[2] and 56,000 deaths in the United States in 2017,[3,4] it is important to understand the risk factors associated with its transmission and prognosis.

Age is a major risk factor in both acquiring CAP and needing hospitalizations due to CAP.[5] There is a bimodal distribution of the incidence of pneumonia, with children under 5 years old and the elderly (older than 65 years of age) being the most affected.[5,6,7] It is hypothesized that, with the impairment of the immune system (due to malnourishment in the developing child and decline of the immune system due to age),[8,9] there is an increased incidence of pneumonia in these patient populations.[5,7]

Tobacco use and alcohol consumption are also risk factors for pneumonia. Tobacco use, including the use of vaping and e-cigarettes—whether through firsthand or secondhand smoking—can increase the risk of developing pneumonia.[10–13] Current smokers with CAP may develop severe sepsis and require hospitalization at a younger age.[10] Alcohol, much like tobacco, increases the risk of acquiring pneumonia, with individuals suffering from alcohol use disorder found to have an 8-fold increased risk.[14]

Established risk factors that can increase the risk of potentially acquiring pneumonia are obesity, immunosuppression (eg, HIV/AIDS), post-viral state and diabetes mellitus.[5,15] Conditions that interfere with swallowing and gag reflex, such as neurological disorders and stroke, also increase the risk of developing aspiration pneumonia.[1]

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Lastly, certain comorbidities can alter the health outcomes and increase the complexity of clinical management of pneumonia. Comorbidities, such as chronic obstructive pulmonary disease (COPD), emphysema, asthma and other chronic respiratory diseases, can increase the chances of acquiring CAP and may have more severe complications due to underlying pulmonary impairment.[5,6,15] Likewise, chronic heart disease, chronic liver disease, diabetes and chronic kidney disease can increase the risk of CAP.[6,16,17]

HAP is pneumonia that occurs 48 hours or more after admission and did not appear to be incubating at the time of admission.[18]

While risk factors overlap between CAP and HAP, such as underlying lung conditions and chronic renal failure,[15,18] there are some risk factors unique to HAP. These include endotracheal intubation and mechanical ventilation, intensive care unit (ICU) admission within the past month, thoracic surgery, and blood transfusion.[18]

The use of a validated predictor scoring tool, such as the pneumonia severity index (PSI) and CURB-65, can be helpful to the clinician and are outlined in Tables 1 and 2, respectively. The PSI in particular takes comorbidities into account and reflects them in calculation for the total score.[19,20]

TABLE 1:

PSI characteristics, point values and scoring system with recommended site of care[19,20]

PSI								SCORING SYSTEM*	
Demographic		**Coexisting Illness**		**Physical Exam Findings**		**Lab and Radiograph Findings**		**Total Points**	**Recommended Site of Care**
Men	Age in years	Neoplastic disease	+ 30	Altered mental status	+ 20	Arterial pH < 7.35	+ 30	< 50	Outpatient
Women	Age in years - 10	Liver disease	+ 20	Systolic blood pressure < 90 mm Hg	+ 20	Blood urea > 30 mg/dl	+ 20	51–70	Outpatient
Nursing home resident	+ 10	Congestive heart failure	+ 10	Respiratory rate > 30 per minute	+ 20	Sodium < 130	+ 20	71–90	Outpatient/brief inpatient
		Cerebro-vascular disease	+ 10	Temperature < 95 or > 104°	+ 15	Glucose > 250	+ 10	91–130	Inpatient
						Hematocrit <30%	+10		
		Renal disease	+ 10	Pulse > 125 BPM	+ 10	Oxygen saturation < 90%	+ 10	> 130	Inpatient
						Pleural effusion	+ 10		

*Example: An 80-year-old female (+ 80 - 10 = + 70) living in a nursing home (+ 10) with a respiratory rate of 32 breaths per minute (+ 20), a pulse of 130 beats per minute (+ 10) and a pleural effusion (+ 10) would have a PSI of 120 and is recommended to be treated as an inpatient.

TABLE 2:

CURB-65 characteristics, point values and scoring system with recommended site of care[16,17,20]

CURB-65		SCORING SYSTEM	
General Characteristics		**Point**	**Recommended Site of Care**
Confusion	+ 1	0/1	Outpatient
Blood urea nitrogen > 20	+ 1	2	Brief inpatient
Respiratory rate > 30/min	+ 1	3 or more	Inpatient
Systolic BP < 90 or diastolic < 60	+ 1		
Age > 65	+ 1		

Symptoms/causative organisms

The transmission of pathogens is generally through the inhalation of air droplets expelled from a carrier; however, pathogens can be transmitted via contact as well.[21] Carriers can, but do not always, exhibit symptoms depending on the pathogen and the efficacy of their immune system. Table 3 shows the different subtypes of pneumonia, their general signs and symptoms, physical exam findings, and common microbiology. Overlap among subtypes is common, so a thorough patient history, a physical exam, diagnostic imaging and microbiologic cultures are necessary to establish the correct diagnosis. Likewise, this table is not completely exhaustive, as more than 50% of pneumonia goes diagnosed without a causative microbe detected[21] and the signs and symptoms can vary greatly between cases.

TABLE 3:

Potential symptoms and physical exam findings, chest x-ray (CXR) results and common microbiology for each pneumonia subtype[5,21]

PNEUMONIA SUBTYPE	SYMPTOMS	PHYSICAL EXAM (PE)/ IMAGING	MICROBIOLOGY
"Walking"/Interstitial	Progressive shortness of breath with exertion, persistent non-productive cough	**PE:** rales bilaterally, less likely to manifest physical exam findings **Imaging: CXR**: Diffuse patchy infiltrates/bilateral multifocal opacities	**Bacteria:** *Mycoplasma*, *Legionella*, *Chlamydophila pneumoniae* **Viruses:** *Respiratory syncytial virus*, *Coronaviruses*, *Cytomegalovirus*, *adenoviruses*, *influenza*
Community acquired	Cough with discolored sputum production, dyspnea, pleuritic chest pain	**PE:** tachycardia, tachypnea, presence of rales/rhonchi in affected area, fever, hypoxemia **Imaging:** CXR: Consolidation or infiltration in affected area (lobar consolidation, interstitial infiltrates)	**Bacteria:***Streptococcus pneumoniae*, *group A Streptococci*, *Staph aureus* (MRSA*, VRSA**), *some gram negative (E.coli*, *Enterobacteriaceae)* **Viruses**: Influenza, adenoviruses, parainfluenza, Coronaviruses
Hospital acquired (nosocomial)	**Symptoms occur > 48 hours after admission**, cough with discolored sputum production, dyspnea, pleuritic chest pain	**PE:** tachycardia, tachypnea, presence of rales/rhonchi in affected area, fever, hypoxemia **Imaging:** CXR: Consolidation or infiltration in affected area (lobar consolidation, interstitial infiltrates)	**Bacteria:** *Staph aureus* (MRSA*, VRSA**), *Streptococcus species*, *Pseudomonas aeruginosa*, *E.coli* **Viruses:** *Influenza*, *adenoviruses*, *parainfluenza*
Aspiration	**Symptoms occur > 48 hours after compromised upper airway,***** cough with discolored sputum production, dyspnea, pleuritic chest pain	**PE:** tachycardia, tachypnea, presence of rales/rhonchi in affected area, fever, hypoxemia **Imaging:** Consolidation or infiltration in affected area (most likely in lower right lobe due to anatomical location)	**Bacteria:** *Klebsiella*, *Hemophilus influenzae*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* **Viruses:** unlikely due to the nature and mechanism of the disease process

*MRSA: methicillin-resistant *Staphylococcus aureus*
**VRSA: vancomycin-resistant *Staphylococcus aureus*
***Compromised airway includes reduced consciousness due to seizure or alcoholism, endotracheal intubation, dysphagia from neurological defects

DIFFERENTIAL/TREATMENT

It is important for physicians to consider other causes for the symptoms above before a diagnosis of pneumonia can be made. Other disease entities—such as asthma, atelectasis, bronchitis, COPD, malignancy, tuberculosis and foreign body aspiration—should be considered. As the use of e-cigarettes/vaping becomes more prevalent, the inclusion of associated lung inflammation and injury should be considered.[12]

It is also important for family physicians to know their limitations. If a patient has fever for several days, hypotension, or tachypnea, or is potentially septic or has a history of being immunocompromised, it may be best to send the patient to the hospital for evaluation and management. The PSI and the CURB-65 severity scoring system have both been used to guide clinical decision-making to illustrate the need for hospital admission with these criteria.[20] The PSI has been illustrated to have an increased sensitivity over that of the CURB-65 when comparing the need to hospitalize a patient. Both scoring systems should be used as tools to aid in medical decision-making and never replace clinical judgment when making a final diagnosis or treatment plan.[20]

Initial considerations for the treatment of pneumonia require differentiating between a viral or bacterial cause. Often, detection of the pathogen may not be possible because 50% of the time, the specimens are inconclusive.[21] However, when pathogens are identified, pediatric patients are more likely to suffer from viral infection alone (82%) with an 8% potential for coinfection.[22] For adults where the pathogen was detected, 62% were viral infections and 29% were bacterial.[22] Among bacterial infections, gram-positive bacteria are the most common, comprising nearly a quarter of all cases of bacterial infections.[21]

Initial treatment strategies for outpatient CAP for a healthy adult without comorbidities are amoxicillin, a macrolide or doxycycline. The choice of three different medication classes allows the clinician to tailor antimicrobial therapy if the patient has specific allergies or contraindications to any individual agent. For patients with a history of recent antibiotic use or other comorbidities, broader-spectrum antimicrobial treatment is recommended and is supported by recent clinical practice guidelines.[23] Outpatient adults with comorbidities, including but not limited to those seen on the PSI, can receive combination therapy. Combination therapy includes amoxicillin/clavulanate or a cephalosporin and a macrolide or doxycycline.[23] Alternatively, a respiratory fluoroquinolone can be used as a monotherapy substitute.[23]

Standard empiric treatment for hospitalized adults with severe CAP without risk factors is a beta-lactam/macrolide combination.[23] Corticosteroids are not recommended in the absence of refractory septic shock.[23] At this time, it is not suggested that routinely adding anaerobic coverage for suspected aspiration pneumonia be standard practice, unless an abscess or empyema is suspected.[23] Finally, it is recommended that clinicians empirically treat for methicillin-resistant *Staphylococcus aureus* (MRSA) or *P. aeruginosa* in adults with CAP, if there are locally validated risk factors for the pathogen present, with vancomycin for MRSA and piperacillin-tazobactam for *P. aeruginosa*.[23]

If the suspected pathogen is viral, then the appropriate treatment is supportive. For certain populations, antibiotics may be used for concomitant bacterial infection. Specifically, with adults who test positive for influenza, data has illustrated that the use of anti-influenza agents in the outpatient setting reduces the duration of symptoms and lowers the likelihood of lower respiratory tract complications, with the greatest effect of therapy if received within 48 hours of the onset of symptoms.[23] For inpatient or outpatient settings, antibacterial treatment should be prescribed for patients who test positive for influenza with radiographic evidence of CAP.[23]

Duration of antibiotic treatment should be no less than 5 days and should be continued until the patient is clinically stable.[23] Once treatment is complete, and the patient has improved within 5–7 days, a follow-up CXR is not recommended at this time.[23]

INTEGRATION OF OSTEOPATHIC MANIPULATIVE TREATMENT

Osteopathic manipulative treatment (OMT) can help the osteopathic physician provide symptomatic relief more efficiently and reduce the patient's recovery time.[24] The patient's management should integrate OMT guided by the 5 models of osteopathic treatment.

The 5 models of osteopathic treatment are: biomechanical, metabolic, respiratory-circulatory, neurological and behavioral.[25] These models provide the framework for developing a complete osteopathic care plan. The models are not used in isolation but are interwoven to optimize the body's ability to heal itself.

Biomechanical model

Common structural findings in patients with pneumonia include rib dysfunctions, diaphragmatic restrictions and hypertonicity of accessory respiratory muscles, as well as clavicle, thoracic and cervical dysfunctions.[24,26] The accessory muscles include the scalene, sternocleidomastoid, pectoralis, serratus anterior and latissimus dorsi. These are often hypertonic in individuals who suffer from dyspnea[27] and, when in dysfunction, can alter the mobility and function of their associated bones in the cervical, thoracic, clavicular and scapular regions. These structural abnormalities continue to worsen the inspiratory and expiratory mechanism of breathing and can result in delayed healing.[24] Using methods like muscle energy; balanced ligamentous tension (BLT); or high-velocity, low-amplitude technique can reduce these acute structural abnormalities and continue to assist the body in the healing process.[24]

Metabolic model

Hypoxia and an increased respiratory rate increase the amount of energy needed for breathing, which increases the metabolic load.[27] This increased metabolic load will divert energy from the body's immune response and redirect it to the inspiratory effort. OMT, including techniques such as rib raising, paraspinal muscle stretch and doming of the respiratory diaphragm, can help improve movement of the thoracic cage.[24] This reduces the difficulty of breathing, decreases the metabolic load for the muscles of respiration and allows the body to utilize its energy elsewhere.

Respiratory-circulatory model

The upper right side of the body, the right side of the head and neck, and portions of the lung drain into the right lymphatic duct, while the rest of the body drains into the thoracic duct.[28] When obstruction to lymphatic flow occurs, the body structure must be optimized to allow for the efficient circulation of the lymph. During pneumonia, inflammation causes a physiologic swelling in the lungs, contributing to congestion and third spacing of fluid that further increases the stress on the body.[28] Lymphatic flow relies on general respiration and normal body motion.[28] However, with decreased effective respiration and inactivity, the body has difficulty moving lymphatic fluid.[28]

There are multiple techniques to increase lymphatic motion by improving breathing mechanics or by treating the obstructed areas of lymphatic flow. To increase chest expansion at the axillary and sternal levels and increase peak expiratory flow rate, techniques such as rib raising, soft-tissue myofascial kneading, thoracic inlet release, thoracic lymph pump, pectoral traction and suboccipital decompression can be used.[29] Techniques such as doming the diaphragm and optimizing movements via attachments to the anterior costal margins with counterstrain and muscle energy may improve lymphatic flow.[24,25,30] A multicenter osteopathic pneumonia study in elderly patients illustrated the benefits of 20 minutes of OMT with techniques such as rib raising, doming the diaphragm and thoracic inlet release.[31] When compared to subjects not receiving OMT, patients aged 50–74 had a decreased length of stay in the hospital, and those over than 75 years old had both decreased mortality and ventilator-dependent respiratory failure rates.[31] Table 4 illustrates techniques that can be used and their corresponding effects.

TABLE 4:

Common OMT techniques and potential effects

OMT TECHNIQUES	LOCATION	POTENTIAL TREATMENT EFFECT
Direct and Indirect Techniques (MET/CS/FPR/BLT/ STILL)*	Suboccipital, occipitoatlantal[24]	· Normalize parasympathetics via treatment of the vagus nerve
	Suboccipital, occipitoatlantal, cervical spine[24]	· Reduce strain and hypertonicity of accessory muscles of respiration
	Thoracic cage[24]	· Optimize movement of thoracic cage by relaxing intercostal margins · Improve range of motion of ribs · Improves lymphatic drainage by allowing for improved pressure gradient changes with respiration
	First rib[30]	· Enhances respiratory motion at thoracic inlet · Relaxes anterior and middle scalene · Removes some restrictions at thoracic inlet
	Rib heads T1–T4[30]	· Inhibit and normalize sympathetic chain in area where lung viscero-somatic reflexes are active
	Rib costal margins T11–T12[30]	· Improves diaphragmatic motion via treatment of diaphragm attachments
Respiratory Diaphragm Doming	Diaphragm[30]	· Restores proper diaphragmatic tone · Facilitates lymphatic pump action of the diaphragm
Thoracic Inlet Release	Thoracic inlet[30]	· Removes myofascial restrictions in the region of terminal lymphatic drainage · Increases thoracic cage mobility
Lymphatic Pump	Pedal pump[24]	· Augments lymphatic drainage from the lower extremity back to the body · Creates oscillatory waves moving fluid across the body
*MET: Muscle Energy, CS: Counterstrain, FPR: Facilitated Positional Release, BLT: Balance Ligamentous Tension, STILL: Still Technique		

Neurological model

It is important to consider viscero-somatic reflexes when treating patients with pneumonia. These reflexes are due to localized visceral stimuli producing patterns of reflex response in segmentally related somatic structures.[25] Viscero-somatic reflexes manifest as tissue texture changes, tenderness, bogginess and warmth over the paravertebral regions associated with the involved viscera. During pneumonia, the sympathetic innervation to the lungs could manifest these reflex changes at the level of T1–T6.[25,26,29,30] The upper cervical spine may show similar changes representing the parasympathetic nervous system.[24,25,26] Additionally, Chapman reflexes, described as subcutaneous lymphatic congestion, and gangliform contractions,[26] may manifest themselves parasternally in the third and fourth intercostal spaces on the side of the affected lung anteriorly. Posteriorly, they are located midway between the transverse and spinous processes of T3 and midway between the transverse and spinous processes of T4 on the affected side.[26]

To balance the autonomic nervous system and attempt to maintain homeostasis, treatment of the upper thoracic and upper cervical regions may be performed with various techniques, including paraspinal inhibition and suboccipital release.[25,30] Paraspinal inhibition helps treat the sympathetics by working on the sympathetic nerve chains anterior to the rib heads.[24,25] Treating the suboccipital region addresses the lung's parasympathetic innervation due to the proximity of the vagus nerve.[24,25]

Behavioral model

Quality of life and psychological health are often altered in patients with pneumonia. The severity of chronic infections correlates with impairments in well-being and sleep. Reducing the severity, duration or frequency of infections can increase quality of life. OMT has been demonstrated to assist the body's ability to mentally heal itself and reduce anxiety.[32]

CONTRAINDICATIONS TO OMT

Consent is required before beginning OMT. Once treatment begins, pain and discomfort should be monitored continuously to ensure patient tolerance. It is important to remember that some techniques should not be performed on specific patient populations. Contraindications for performing OMT include, but are not limited to, active infections with a temperature over 102°F (38.89°C), osseous fractures in the area of treatment, thrombotic events and certain stages of carcinoma.[33] Patients with a medical history of osteoporosis and rheumatoid arthritis should also be treated with consideration for their weak structural integrity and joint instability.[26] The physician should be aware of any contraindications to the techniques that they will perform prior to treating with osteopathic manipulation.

CONCLUSION

Patients with pneumonia commonly present to the osteopathic family physician. Evaluation of these patients involves a thorough history, investigation into any comorbidities, a thorough physical exam, use of a validated scoring system and diagnostic studies. correct diagnosis and management plan. A thorough treatment plan should include OMT and integrate all 5 models of osteopathic treatment. Osteopathic manipulative techniques should be included in the treatment plan and have been demonstrated to positively impact the patient's physical and mental health.

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