Journal of Community Hospital Internal Medicine Perspectives

Volume 12 | Issue 4 Article 6

2022

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Recommended Citation

Finn, Arkadiy; Selvaraj, Vijairam; Peterson, Elijah; Banerjee, Debasree; Lal, Amos; Grewal, Himmat; Martin, Edward; and Dapaah-Afriyie, Kwame (2022) "MANAGEMENT OF THE PATIENT WITH CHRONIC CRITICAL ILLNESS – PART 1," *Journal of Community Hospital Internal Medicine Perspectives*: Vol. 12: Iss. 4, Article 6.
DOI: 10.55729/2000-9666.1065
Available at: https://scholarlycommons.gbmc.org/jchimp/vol12/iss4/6

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REVIEW ARTICLE

Management of the Patient with Chronic Critical Illness – Part 1

This is part one of a two part series. Part two will be published in September

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Abstract

Patients with chronic critical illness (CCI) represent a growing segment of the hospitalized population. Key aspects of care in CCI patients including tracheostomy, prolonged mechanical ventilation, nutritional support, wound care, and others require a comprehensive, goal-directed approach. Infectious complications of CCI including pneumonia, tracheobronchitis and urinary tract infection may be caused by nosocomial organisms requiring awareness and adjustment of treatment regimen. Finally, psychiatric, palliative, rehabilitative components of care impact heavily upon outcomes in CCI patients. As care that is typically associated with the intensive care unit is extended to the hospital ward, we aim to increase awareness among providers and outline a systematic approach to deliver high quality, patient centered care to CCI patients.

Keywords: Chronic critical illness, CCI, Persistent critical illness, Chronic illness, LTACH, Medically complex patients

1. Introduction

Hospital providers are increasingly faced with the task of caring for patients whose hospitalization may be prolonged due to chronic critical illness (CCI).[1] Although these patients represent a small proportion of overall acute inpatient volume, their management is likely to be complex and time-consuming. The patient with CCI may transition to the inpatient hospital service after extended stays in intensive care unit (ICU); from the pediatric population after exceeding the age limit of pediatric hospitals, and other settings where complex illness is extended over time through intensive clinical management. Additionally, the Coronavirus Disease-19 (COVID-19) pandemic has led to an increase in acute respiratory failure and ICU utilization with resultant increases in patients requiring prolonged hospitalization as they recover from complications of critical illness.[2,3] Often these patients end up on hospital wards and transition between services, without progressing overall care

Received 5 February 2022; revised 23 February 2022; accepted 1 March 2022.
Available online 4 July 2022

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https://doi.org/10.55729/2000-9666.1065

plans. Providers who take on these cases must spend time reviewing charted records sometimes going back months, or even years, and may find the number of complex medical issues challenging to combine into a unified plan of care. We believe that their care can be improved by changing management and communication practices using a multidisciplinary approach. In this article, we discuss common aspects of long-term hospitalized CCI patient care and outline an objective and systematic approach for the clinician.

2. Definitions

Chronic critical illness is loosely defined as the group of patients who require care typically associated with the ICU setting.[4] The concept of prolonged hospitalization does not have an established definition but, may be understood as a hospitalization which has lasted for greater than 21 days, with or without clearly identified criteria for discharge and post-discharge disposition.[5,6] Patients with CCI are likely to have exhibit a complex mix of clinical conditions: respiratory failure requiring prolonged mechanical ventilation via tracheostomy, gastrostomy tube dependence, complex wounds, malnutrition, severely decreased functional status, among and other organ failures.[7] Patients undergoing prolonged hospitalization for CCI commonly have care needs which exceed the level provided by home visiting nurse agencies, nursing homes and skilled nursing facilities. Long-term acute care hospitals (LTACH), care settings which came into being in the 1980s to address the needs of patients requiring prolonged ventilatory support have limited bed capacity or may not support a combination of complex issues such as hemodialysis and a tracheostomy with ventilator dependence. The concepts discussed here are fully applicable to the LTACH patient.

3. Specific aspects of care

3.1. Tracheostomy and prolonged mechanical ventilation

CCI patients may exhibit partial or complete dependence on mechanical ventilation and are likely to have undergone tracheostomy placement.[8] Among hospital discharges with respiratory failure and invasive mechanical ventilation, an average of 9.6% received tracheostomy in the hospital between 2002-2017.[9] Reported rates of tracheostomies utilized during the coronavirus pandemic vary significantly from 16% to 61%, but are likely higher than pre-pandemic rates.[9,10] Factors associated with prolonged dependence upon mechanical ventilation include systemic, respiratory, neurological, and other conditions. Respiratory illnesses such as chronic obstructive pulmonary disease and acute complications including diaphragmatic weakness, decreased respiratory muscle reserve, and ineffective cough is commonly encountered. Critical illness neuromyopathy, and psychiatric causes such as depressed mood or severe anxiety may also contribute.[8]

Management objectives for patients chronically dependent on mechanical ventilation include weaning from ventilatory support and tracheostomy care. Several weaning approaches including progressive reduction in pressure support ventilation (PSV), progressively increased spontaneous breathing trials, non-invasive ventilation and others have demonstrated efficacy.[11] Weaning protocols generally share the aim of gradually decreasing patient dependence on mechanical ventilation with the ultimate goals of liberation and tracheostomy decannulation. A protocolized approach to long term weaning has been shown to be superior to a non-protocolized approach, independent of a specific ventilation strategy.[12] Some patients may not completely wean from mechanical ventilation, particularly in conditions involving progressive neurological decline. A multi-disciplinary approach involving respiratory therapy, physical/occupational therapy and pulmonary medicine is the most likely to achieve success as factors outside of the respiratory system including overall functional status, nutrition, alertness, and mood play a large role in successful weaning.[13]

Tracheostomy tubes are available in a variety of configurations and types (cuffed, uncuffed, with/without inner cannula) and are chosen based on the patient's anatomy and mechanical ventilation needs. Routine care may include humidification of inspired air, tracheal suctioning, cleaning of the inner cannula (if present), and inspection of tube positioning and cuff pressure, with adjustment as required. Complications encountered with tracheostomy care may include bleeding and loss of airway in the immediate post-placement period; obstruction and partial or complete displacement in the intermediate term; and development of tracheomalacia and tracheal stenosis in the long-term.[8]

Red flags, or specific indicators of an impending tracheostomy problem, may include gas escaping through the upper airway or formation of saliva bubbles at the mouth or nose indicating a malpositioned tube or insufficient cuff pressure. The tracheostomy may be visibly displaced and require removal and exchange or repositioning. The inner

tube may become obstructed with viscous or inspissated secretions and may require suctioning or exchange. Options for emergency oxygenation may include ventilation via the face mask or intubation via vocal cords; in addition, emergency consultation with surgical, anesthesiology, or pulmonary medicine services should be obtained. Clinicians should engage with tracheostomy care specialists within their institution including respiratory therapy, otolaryngology, and pulmonary medicine. The United Kingdom National Tracheostomy Safety Project serves as a resource for guiding bedside staff in tracheostomy care and airway emergencies in this population.[14] Long term outcomes are generally poor (one year mortality up to 78%) but prognosis improves with successful weaning.[15]

3.2. Nutritional support

Malnutrition is highly prevalent in hospital inpatients, up to 60% in some reports and is more likely to occur in elderly and critically ill patients.[16] Malnutrition is associated with increased morbidity, decreased wound healing, loss of muscle mass and increased risk of infectious complications. The European Society for Clinical Nutrition and Metabolism (ESPEN), recommends nutritional screening of inpatients with validated screening tools to assess malnutrition.[17] For those patients who can safely tolerate oral intake oral nutritional supplementation high in energy and protein is recommended.[17] When nutritional requirements cannot be met orally, enteral nutrition is recommended over parenteral nutrition whenever possible.[18] Energy requirements may be estimated from a prediction equation or weight-based calculation. Vitamin and trace elements should be supplemented when deficiency is documented or suspected. Nutritional support should be initiated early in the hospital stay and aim to meet 75% of the patient's energy or protein requirements to improve clinical outcomes.[17]

In practice, many patients fail to meet their intake requirements orally and undergo placement of nasogastric or gastrostomy tubes for enteral feeding. Small-bowel placement of feeding tubes is recommended to reduce risk of aspiration despite mixed evidence of efficacy.[18] Upon initiation, patients should be monitored for refeeding syndrome which may manifest as hypophosphatemia, hypokalemia and hypomagnesemia and screened for thiamine deficiency. Enteral nutrition is generally well-tolerated, but patients should be monitored for gastric residual volume, constipation, diarrhea, vomiting and abdominal distention.[19]

Total Parental Nutrition (TPN) is the intravenous supplementation of nutrients and is referred to as "total" when it is the exclusive feeding method for the patient. Initiation of parenteral nutrition should occur when enteral nutrition is not feasible in malnourished or at-risk patients.[20] TPN is administered through a central venous catheter and generally consists of carbohydrate, lipid, and amino acid components. TPN provides nutrition but is not likely to reverse cachexia resulting from various disease states. Complications of TPN include venous catheter infection and thrombosis; increased rates of sepsis, due to fungemia; hepatobiliary involvement including steatosis, biliary stasis, cirrhosis; and renal disease through the pathway of oxalate nephropathy.[20]

3.3. Complex wound care

Pressure injuries resulting in ulceration and wound formation frequently occur in critically ill and immobile patients. Pressure injuries occur when pressure is applied to the skin overlying a bony prominence resulting in ischemia. The sacrum, heel and ischium are common sites in order of frequency for pressure ulcer formation.[21] Moisture accumulation particularly through urinary or fecal incontinence may accelerate wound formation and prevent healing. Other risk factors include malnutrition, cachexia, immunocompromise, and severe neurological disease.[22]

Wounds should be monitored for infection which may present as swelling, erythema, purulent drainage, wound expansion, and subcutaneous tunneling. Osteomyelitis of the bony tissues underlying deep wounds is a frequent complication and often requires surgical debridement, in addition to antibiotic treatment. Antibiotic therapy should be based upon cultures, obtained from deeper sites within the wound, if possible, to avoid culturing superficial contamination and colonizing organisms.[23]

Treatment of pressure injuries should focus on pressure off-loading; optimization of existing risk factors including malnutrition, immobility, and moisture sources; evaluation for infection and local wound care.[24] Strategies aimed at debridement of necrotic wound tissue may include wet-to-dry dressings, high-pressure irrigation, enzymatic debridement in addition to sharp debridement and vacuum-assisted closure. Surgical evaluation should be obtained for wounds with exposed deep tissues, large amounts of necrosis and other complications impeding wound healing. Surgical treatment may include wound excision and closure with skin flaps. Clinicians should employ a multidisciplinary

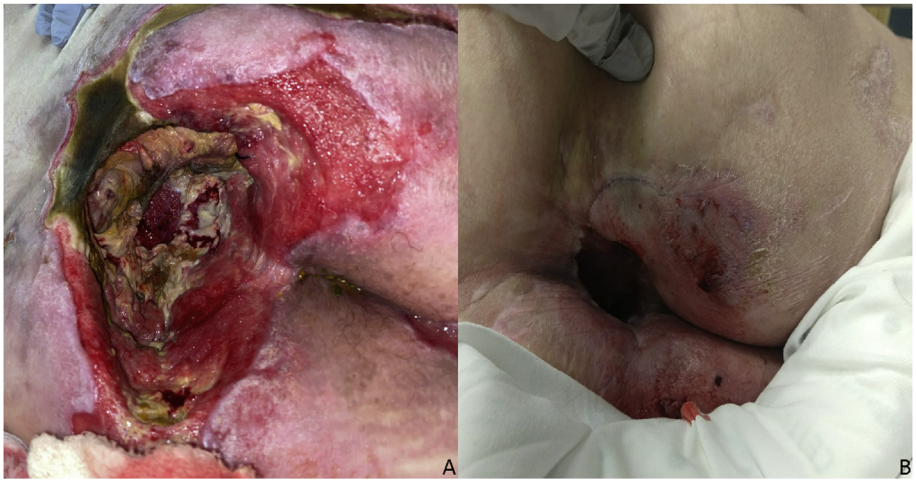

Fig. 1. Sacral wound displaying before (A) and after (B) images over 8 month long period of treatment with pressure off-loading, as well as collaborative wound care involving hospitalists, nurse wound specialists, and plastic surgeons during a prolonged hospitalization for CCI.

approach involving wound care specialists from nursing and surgical fields (see Fig. 1).

3.4. Infectious complications

3.4.1. Tracheobronchitis and pneumonia

Tracheostomy with or without chronic ventilator support increases the risk for colonization of airways with pathogens and the subsequent development of inflammatory processes in the bronchioles, bronchi and trachea resulting in tracheobronchitis. Diagnosis of bacterial ventilator-associated tracheobronchitis (VAT) requires the absence of pulmonary infiltrates and at least 2 of the following: 1) fever (>38 °C) 2) cough, 3) new or increased production of sputum, 4) rhonchi and wheezing and 5) bronchospasm.[25] Management of tracheobronchitis is by using antipyretics, mucolytic agents, humidified oxygen and other supportive measures and antibiotics in cases of confirmed bacterial infection. Antibiotic choices should cover potential gram-positive and gram-negative pathogens such as *Streptococcus pneumoniae*, Methicillin Resistant Staphylococcus Aureus (MRSA) and Pseudomonas species.[26] Nosocomial viral infections should also be considered.

Patients with ventilator-associated pneumonia (VAP) meet criteria for VAT but also have new lung infiltrates.[27] As with cases of VAT, initial choices of antibiotics should cover common culprit pathogens with consideration for two antipseudomonal agents of different classes if risk factors for resistance are present or predisposing lung disease such as bronchiectasis and cystic fibrosis. The duration of treatment is seven days but may be shorter or longer depending on clinical response.

3.4.2. Complicated urinary tract infection (UTI)

Complications of long-term urinary catheterization (>30 days) include asymptomatic bacteriuria, Catheter-Associated Urinary Tract Infection (CA-UTI), catheter obstruction, renal and bladder calculi formation associated with urease-producing pathogens, and fistula formation. CA-UTI in patients with indwelling urethral, suprapubic, or intermittent catheterization is defined by the presence of symptoms or signs compatible with UTI, along with $\geqslant 10^3$ colony-forming units (cfu)/mL of $\geqslant 1$ bacterial species in a single catheter urine specimen.[28] Signs and symptoms compatible with CA-UTI include new onset or worsening of fever, rigors, altered mental status, malaise, or lethargy with no other identified cause; flank pain; costovertebral angle tenderness; acute hematuria; pelvic discomfort; and in those whose catheters have been removed, dysuria, urgent or frequent urination, or suprapubic pain or tenderness. A urine specimen for culture should be obtained before starting antimicrobial therapy for presumed CA-UTI because of the wide spectrum of potential infecting organisms and the increased likelihood of antimicrobial resistance.[29] Catheter replacement is required in patients who require an indwelling catheter to hasten resolution of symptoms and to reduce the risk of subsequent bacterial colonization and CA-UTI.

CA-UTI and other infections may be caused by resistant species such as Extended-Spectrum β-Lactamase (ESBL)—producing Enterobacteriaceae. ESBL-producing gram-negative organisms can hydrolyze higher generation cephalosporins that have an oxyimino side chain such as cefotaxime, ceftazidime, ceftriaxone, and cefepime. The carbapenem class of antibiotics (meropenem, ertapenem) is the

preferred agent group for treating ESBL-producing organisms' infections.

3.4.3. Central line–associated bloodstream infections and fungemia

Most central line infections are primary, rather than secondary to bacteremia due to other infections. The most common pathogens are gram-positive organisms, which should guide initial antibiotic choices.[30] Common gram-negative organisms causing Central Line–Associated Bloodstream Infections (CLABSIs) include *E. coli* and Klebsiella species.[30] Appropriate management includes line removal with systemic antibiotic therapy targeted to the most likely organism. Blood cultures should be obtained after catheter removal and initiation of appropriate antibiotic therapy to document clearance of the organism. Treatment should be targeted based on susceptibility results. The duration is 7–14 days for uncomplicated infections. Complicated cases may require a longer course of treatment.[31]

Candida species are the fourth most isolated organisms in bloodstream infections and are associated with a mortality rate up to 40%.[31] Identification of yeast cells in the blood and on the catheter indicates candidemia. Risk factors for candidemia include central venous or hemodialysis-associated catheters, use of broad-spectrum antimicrobial agents, TPN, ICU stay or mechanical ventilation for more than three days, transplantation, and neutropenia.[32] Candidemia can present as an isolated fever or septic shock. It may also be associated with endocarditis, meningitis, and peritonitis. Initial treatment of candidemia and invasive candidiasis should include an echinocandin (caspofungin, micafungin, or anidulafungin) and intravascular device removal if feasible.[32] A funduscopic examination is also necessary to exclude endophthalmitis. Other infectious complications include *Clostridium difficile* colitis, acalculous cholecystitis, wound and PEG tube insertion site infections.

Disclaimer

The manuscript has not been submitted to other publication or presented at a conference or meeting.

Conflict of interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript. Arkadiy Finn, Vijairam Selvaraj, Elijah Peterson, Debasree Banerjee, Amos Lal, Himmat Grewal, Edward Martin, Kwame Dapaah-Afriyie.

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