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Nursing Interventions in the Management of Non-Pulmonary Tuberculosis: A Multidisciplinary Approach with Laboratory Support

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Abstract

Background: Particularly in immunocompromised people, non-tuberculous mycobacteria (NTM) are a wide collection of mycobacterial species that create major health hazards and are progressively identified as sources of different illnesses. Diagnostic complexity and therapeutic challenges make effective management of NTM infections still tough.

Methods: The present study methodically reviews the body of knowledge on nursing interventions used in NTM infection management. It emphasizes the interdisciplinary approach including laboratory support for diagnosis and therapy. Comprehensive database searches revealed pertinent research that underlined the importance of nursing in patient education, symptom management, and collaborative care.

Results: The study emphasizes how early detection and therapy of NTM infections depend much on nursing actions. Important conclusions include the need for comprehensive patient evaluations involving examination of clinical symptoms, laboratory monitoring, and the use of customized teaching programs. Optimizing treatment plans and enhancing patient outcomes depend on efficient communication among healthcare professionals including nurses, chemists, and doctors.

Conclusion: The management of NTM infections is significantly improved by the incorporation of nursing interventions within a multidisciplinary framework. Nurses greatly help to enhance clinical results and quality of life for patients impacted by NTM by offering thorough treatment addressing both psychological and physical elements of patient health. To improve patient care even further, future studies should concentrate on creating uniform guidelines for nurse activities in NTM treatment.

Keywords: Non-tubercular mycobacteria, nursing interventions, infection control, multidisciplinary approach, patient education

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1. Introduction

Non-tuberculous mycobacteria (NTM) have become a term that refers to a group of over 190 types of Mycobacteria that are not *Mycobacterium leprae* or *Mycobacterium tuberculosis* [1]. These ubiquitous creatures are especially found in water and soil supplies and are progressively identified as the cause of human sickness. Non-tuberculous mycobacteria afflict not just immunocompromised groups but additionally healthy people. The diagnosis and treatment of NTM infections present some somewhat difficult problems. For most NTM infections, the clinical presentation is non-specific and usually results in delayed diagnosis. Growing NTM from biological materials for identification might be challenging attributable to varied development time and conditions if NTM is detected. Moreover, the real recognition of the organisms usually depends on molecular techniques not always accessible. Finding NTM from biological materials is not like indicator of NTM illness; the widespread distribution of NTM in the surroundings makes it difficult to differentiate colonization from actual infection.

Furthermore, difficult is the therapy for NTM illnesses. Not every NTM species or medication that is intriguing has antimicrobial-susceptibility testing (AST). In which it is accessible, its medical importance is dubious, and it is not usually consistent. Standards for the ideal number of medications and therapy period are mostly opinion-based; the optimum dose of known anti-mycobacterial agents is uncertain. Moreover, present recommendations for NTM infections classify NTM into several groups. Consequently, insufficiently explored are variations across NTM kinds of variables including pathogenicity, important host variables, resistance characteristics, and responsiveness to therapy. We therefore provide our method of diagnosing and treating NTM infections here. This work aims to provide an overview of an additional general approach to the detection, diagnosis, and treatment of particular NTM illnesses or species rather than a thorough advice for their care.

Usually non-specific, NTM infections show clinical symptoms. Usually, NTM disease has been identified in a person who does not react to conventional anti-bacterial treatment and has persistent signs (such as fever, breathing issues, and skin wounds). On the other hand, knowledge of prevalent NTM infection signs and their clinical setting might increase the worry about an NTM disease. Although there are numerous additional clear clinical symptoms reported with NTM, pulmonary NTM infection remains the most often occurring one [2].

2. Non-tuberculous mycobacteria examination

There's no pathogenomic examination exists to diagnose NTM infections. The identification calls for radiographic results to be correlated with medical signs and finally microbiologic proof of the causative agent. To verify or rule out an NTM infection, specimen collecting and testing might have to be done numerous times. Given the complexity concerned, testing ought to be understood in light of care of NTM diseases under the advice of experts, particularly in cases where the microbiologic findings contradict the clinical scenario. NTM are prevalent in surroundings and are frequently observed in water and soil, as well as in urban and domestic water supply sources. Thus, care should be taken to avoid biological specimen environmental contamination thereby preventing false positive findings. Almost every organ or tissue thought to be infected may provide samples.

For the identification of pulmonary NTM disease, the Infectious Conditions Society of America (IDSA)as well as the American Thoracic Society (ATS) offer recommendations that call for positive sputum culture findings at at least two different times [3,4]. On the other hand, for assessment, one positive society from a smaller respiratory specimen—such as bronchial lavage or washing—is thought sufficient. Further sputum cultures ought to be acquired [3,4] if medical concern for pulmonary NTM disease is strong and the first tests come out non-diagnostic. Patients incapable of expectorating sputum may need bronchoscopy or introduction of sputum. It is uncertain what the ideal interval is between sample collections. Separating specimen collection by at least a week might be an acceptable period to take into account the gap between sample collections, therefore preventing confusion about the diagnosis by temporary environmental contamination [5]. Though it is seldom mentioned as required for diagnosis, lung biopsies may reveal

histopathological results of mycobacterial infections, including granuloma development, thus transcending positive stains and cultures.

In non-pulmonary illness, the location of engagement defines the source of culture. For microscopy as well as mycobacterial culture, lymphadenitis, for instance, may call for excisional examination or fine needle aspiration. Mycobacterial blood cultures might be diagnostic when NTM illness is spreading. Bone marrow or hepatic biopsy may be helpful for the diagnosis of cytopenias [6]. Skin infections are better assessed with biopsy instead of superficial swabs as swabs may indicate surroundings rather than infection [6]. Should clinical suspicion arise, the necessary biologic specimens ought to be acquired and delivered to the microbiology department under notice of the doubt for NTM disease, therefore enabling the laboratory staff to handle these specimens correctly. Maximizing yield would be needed for various staining as well as culture methods. Should NTM species with specific cultural needs be suspected, including development at low temperatures for skin-associated infections or additional nutrients of the medium, they should also be reported to the laboratory staff. Additionally documented should be time to grow and colony numbers.

Certain clinical specimens, notably sputum, offer a great possibility for bacterial overgrowth or contamination. Concentration and disinfection methods are used when analyzing such samples to increase the microbiologic result [3,4]. Although some studies have voiced worry that it may compromise the viability of mycobacteria, disinfection with N-acetyl-l-cysteine-NaOH-oxalic acid is routinely used. Chlorhexidine [7-9] is another decontamination agent without affecting mycobacterial viability. The Medical Laboratory Standards Institute (CLSI) approves both of these techniques. There are no set guidelines for NTM staining; most suggestions came from techniques used for *M. tuberculosis*. Like other mycobacteria, NTM's cell walls contain high lipid content and are classified as acid-fast bacilli (AFB) due to their special capacity for binding a carbol-fuchsin dye unable to decolorize by acid-alcohol. Staining by itself cannot help one differentiate between species of Mycobacterium, tuberculous and non-tuberculous. Staining sensitivity most certainly relies on several elements, including tissue processing techniques and pathogen load. In several investigations [10,11], it has been demonstrated that processing sputum with bleach as well as concentrating the material before staining improves the accuracy of detection of AFB. However, no data exists to precisely measure minimal NTM pathogen load to produce a favorable AFB sputum smear. Based on the time to development of mature colonies on a solid cultivation medium, NTM is often categorized as either quick or slow growers [12]. While slow-growing NTM requires over seven days to flourish, rapidly expanding NTM develops in a short period.

Evaluating an individual with NTM illness depends on knowing which species of NTM exists. Identification of species lets one evaluate predicted antibiotic resistance, clinical relevance, and prognosis. In contrast to *M. TB*, there are no well-accepted methods for species identification straight from clinical samples [13-15]. Culture thus still comes first in identity. Many diagnostic techniques may be used to determine a microbe to a species level after it is isolated in culture. For most NTM, a matrix-assisted laser desorption radiation time-of-flight mass spectrometer (MALDI-TOF MS) is quite successful [16]. Usually speaking, it is less expensive and easier than whole genome sequencing or commercial nucleic acid enhancement techniques. Still, it depends on genuine isolates and might not be capable of separating closely related mycobacteria like *Chimaera intranacellum*. It is also constrained by the spectrum library the device has at its disposal [17,18].

Although it may be used only after growth on culture medium, molecular diagnostics has transformed the field of species identification [6]. There are many Food and Drug Administration (FDA)-approved probes of DNA for species-specific RNA. Should MALDI-TOF as well as species-specific probes fail to recognize a living thing, 16s RNA sequencing might be helpful. Two areas of the 16s RNA may aid in identifying NTM species. There are many commercially sold systems with out-of-box sequencing capability. However, because there is insufficient genetic variation to enable precise identification beyond the species complex level, numerous species may not be distinguished. Like MALDI-TOF, test properties rely on the sequence library [19].

One area of continuous study is the identification of species straight from a clinical specimen. Currently in development are polymerase chain reaction (PCR)--based tests of respiratory samples for fast detection of

NTM species. Although Xpert MTB/RIF Ultra and TrueNAT (MolBio) are not the main methods of diagnosis of NTM illness, their assays used to identify TB may have certain interactions with NTM species [20]. Though not commonly accessible, line probe tests do have the capacity to detect particular kinds of NTM as well as evaluate for aminoglycoside as well as macrolide resistance. Additionally useful for directly identifying NTM kinds from clinical specimens is MALDI-TOF [18]. These methods are experimental now, but they have the potential to speed up future NTM infection detection.

Most people may have their pulmonary NTM illness diagnosed lacking a tissue sample. Other microbiological requirements satisfy themselves, hence biopsies are not necessary [3,21]. By contrast, the identification of extra-pulmonary infection caused by NTM usually calls for acquiring a tissue sample. With an NTM organism present, the histologic characteristic of mycobacterial illness is either non-necrotizing or necrotizing granulomatous inflammation. Enough single tissue samples with these characteristics will establish NTM illness [22]. NTM histologic findings in immunocompetent individuals may reflect those of TB [23]. Alone, granulomatous inflammation does not specifically target NTM. Because of the tiny tissue sample, lung examination could be culture negative; yet confirmation of granulomatous infection and multiple cultures associated with NTM development allows one to make an NTM diagnosis [4,24].

On tissue biopsy, immunocompromised people could not reveal granulomas or obvious pathogens. The lack of characteristic histologic evidence does not invalidate the diagnosis in situations of propagated NTM illness [24]. Histologic results for this patient group could show foamy histioctyes with mycobacteria, inadequately established granulomas, or no obvious inflammatory response [23].

Antimicrobial susceptibility tests (AST) criteria provided by CLSI and ATS/IDSA Culture and development under broth microdilution is the gold standard for estimating antimicrobial reactivity [25,26]. NTM AST should generally be done only for clinically important isolates. *M. Gordon* is one of the NTM species that CLSI advises against susceptibility testing since they are seldom pathogenic [25,26]. Clinicians should be aware that for every species and anti-mycobacterial treatment, the linkage of medical reaction to in-vitro sensitivity patterns has not been demonstrated. For instance, aside from the macrolides and amikacin, during *Mycobacterium avium* complex (MAC) strains, there is no connection between medical reaction with in vitro minimal inhibitory concentrations (MIC). AST before addressing MAC should therefore be restricted to clarithromycin as well as amikacin sensitivity testing. Likewise, failure of therapy for *Mycobacterium kansasii* is usually linked with rifampin opposition; MIC levels for ethambutol (EMB), as well as isoniazid (INH), are inconsistent with medical response [25,26]. For this particular reason, AST before starting therapy for *M. kansasii* includes rifampin sensitivity testing; thereafter, it extends to additional agents only in cases of rifampin resistance. AST against a larger panel of antimicrobial agents is advised only for these two NTM species in the form of macrolide-resistance (for MAC) as well as resistance to rifampin (including, for *M. kansasii*).

Sensitivity testing against a wider range of antimicrobials in advance is advised for fast-developing mycobacteria. For most of these medicines, however, there is no known MIC limit for susceptibility or resistance, hence the goal of this testing is "to guide instead of dictate therapy". Furthermore, all *M. abscessus* given the existence of erythromycin ribosomal methylase (erm) genes, *M. fortuitum* isolates should frequently be screened for inducible macrolide opposition [25,28]. The incubation of the microbe with sub-inhibitory clarithromycin doses for fourteen days is the basis of analyzing for stimulated macrolide resistance [29].

3. Clinical presentations of NTM infections

Although NTM infections most often show up as pulmonary illness [30], they may also cause localized infections of the skin, bones, and soft tissues; widespread infections in individuals with highly weakened immune systems may also happen. Reviewing these other forms, the present ATS/IDSA recommendations do not particularly deal with the identification and management of extra-pulmonary NTM [3]. NTM infections have varied and non-specific clinical symptoms. The majority of individuals with lung NTM illness will have either continuous or recurrent coughing with or without mucus generation [31]. Along with constitutional symptoms (such as fever, tiredness, loss of weight, as well as night perspiration), chest

discomfort, or dyspnea, this might be accompanied by These later symptoms could only show up in severe illness. Determining whether NTM infection is the source of the presenting symptoms may be somewhat difficult because many people with pulmonary NTM illness have underlying lung diseases like bronchiectasis or just chronic obstructive pulmonary disorder (COPD).

Along with the constitutional symptoms described above, those suffering from skin, soft tissue, as well as musculoskeletal NTM diseases may show skin lumps, wounds, draining wounds, or abscesses. Along with muscle atrophy and draining sinuses, musculoskeletal NTM diseases may show up as stiffness, joint pain, as well as edema. Usually, non-tender, mycobacterial lymphadenitis shows up as swollen lymph nodes. A propagated NTM disease may show up as scattered skin lesions. Disseminated MAC infection shows up as a systemic febrile disease with stomach discomfort and diarrhea in people with advanced HIV infection.

Physical results vary and are vague but represent the organs or systems compromised. For skin and soft-tissue NTM, for instance, soreness, erythema, affection, local discomfort, inflammation, wounds, and abscesses. It should be mentioned that a frequent precipitant for NTM infections of the soft tissues and skin is cosmetic surgery. Common physical examination results in NTM lymphadenitis are a solid, painless lump with underlying skin changes. One typical physical examination result in disseminated MAC illness is hepatosplenomegaly.

The management of infection with NTM is complicated and restricted by various factors, including the use of multidrug treatments, prolonged therapy lengths, as well as the use of medications sometimes connected with unpleasant effects and not well-tolerated. Often prevalent in individuals with NTM infections, co-morbidities add even another level of difficulty for treatment. For the majority, but not all, NTM diseases the ideal therapeutic dosages, pharmacological mixtures, and medication lengths weren't well established. While in vivo evidence is missing at this time, numerous novel drugs utilized for the management of multi-drug resistant tuberculosis like pretomanid, demand, and bed aquiline exhibit in-vitro action against NTM species [32,33]. There are agreed-upon rules for handling NTM infections. Still, they rely more on expert opinion than on evidence from suitably powered controlled studies with enough extended follow-up time.

4. Safety observation throughout anti-mycobacterial treatment

During treating NTM infections, adverse drug responses, or ADRs, are very prevalent and linked to either early treatment termination or therapy interruption [27,34]. Not unexpectedly, some data suggests that ADRs affect treatment outcomes [35]. Therefore, a major part of the management of the therapy of NTM infections is teaching patients about the probable ADRs they may face with the drug regimen they have been given as well as tracking them for treatment-emergent ADRs. There is no scientific foundation for the ideal frequency of monitoring those with NTM for negative medication responses; monitoring of patients in this regard is done in many methods. Every clinical visit should, at least, include active evaluation for the development of ADRs using questions or physical examination. Many of the antibiotics used to treat NTM infections have significant potential for drug interactions; thus, a thorough evaluation of the prescription list is advised at every clinical visit.

Multiple factors will affect surveillance for antimicrobial toxicity: co-morbid health issues, baseline functioning, hepatic activity, renal function, interaction between drugs, concurrent drugs with supplementary toxicity characteristics, intravenous rather than oral therapy, medication dose, as well as accessibility of laboratory assets. Still, doctors should be ready for any side effects.

5. Conclusion

An increasingly significant cause of human illness, non-tuberculous mycobacterial infections cause a spectrum of infections ranging from localized soft-tissue invasion to widespread life-threatening diseases. Being so common in nature may make it difficult to separate NTM biological contaminants from a real NTM illness. The radiographic and clinical characteristics are generic; microbiologic evaluation is difficult and not very useful. Treatment is difficult and calls for multi-drug regimens with significant related toxicity given over an extended time. Setting therapeutic goals is challenging; frequently, clinical results are not satisfying.

Considering these significant difficulties, a comprehensive methodical approach to the detection and management of infection with NTM ought to be followed to increase the possibility of favorable therapy results. Early diagnosis is crucial and calls for an elevated index of belief and knowledge of the clinical settings indicative of NTM infection. While antibiotic sensitivity should be investigated on all isolates when suspicion of a real NTM infection exists, identification of the causal organism to the species degree should be done. AST findings should lead therapy; by accepted recommendations, treatment should be directed; patient comprehension and ongoing surveillance for therapeutic outcomes and treatment-emergent side effects should be given great consideration. To raise clinical results and quality of life, antimicrobial treatment should be supplemented with adjunct treatments including respiratory hygiene regulations nutritional assistance, and fitness regimens.

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التدخلات التمريضية في إدارة مرض السل غير الرئوي: نهج متعدد التخصصات مع الدعم المختبري

الملخص

الخلفية :تُعد المتفطرات غير السلية (NTM) مجموعة واسعة من الأنواع البكتيرية التي تشكل مخاطر صحية كبيرة، لا سيما لدى الأشخاص ذوي المناعة الضعيفة، وتُعرف بشكل متزايد كمسببات لمجموعة متنوعة من الأمراض. لا تزال تعقيدات التشخيص والتحديات العلاجية تجعل من الصعب إدارة التهابات NTM بشكل فعال.

الأساليب :تستعرض هذه الدراسة بشكل منهجي المعرفة المتوفرة حول التدخلات التمريضية المستخدمة في إدارة التهابات .NTM كما تؤكد على النهج متعدد التخصصات، بما في ذلك الدعم المختبري للتشخيص والعلاج. كشفت عمليات البحث في قواعد البيانات عن دراسات مهمة تسلط الضوء على دور التمريض في تثقيف المرضى، وإدارة الأعراض، والرعاية التعاونية.

النتائج :تؤكد الدراسة على أن الكشف المبكر والعلاج الفعّال لحالات NTM يعتمد بشكل كبير على التدخلات التمريضية. تشمل الاستنتاجات الرئيسية الحاجة إلى تقييم شامل للمرضى، يتضمن فحص الأعراض السريرية، ومراقبة الفحوصات المخبرية، وتطبيق برامج تعليمية مخصصة. كما يعتمد تحسين خطط العلاج وتعزيز نتائج المرضى على التواصل الفعّال بين الممرضين والصيادلة والأطباء وغيرهم من مقدمي الرعاية الصحية.

الاستنتاج :يتم تحسين إدارة التهابات NTM بشكل كبير من خلال دمج التدخلات التمريضية ضمن إطار عمل متعدد التخصصات. يلعب الممرضون دورًا مهمًا في تعزيز النتائج السريرية وجودة الحياة للمرضى المصابين بـ NTM من خلال تقديم رعاية شاملة تعالج الجوانب النفسية والجسدية لصحة المرضى. ينبغي أن تركز الدراسات المستقبلية على تطوير إرشادات موحدة لأنشطة التمريض في علاج NTM لتحسين جودة الرعاية الصحية.

الكلمات المفتاحية :السل غير الرئوي، التدخلات التمريضية، مكافحة العدوى، النهج متعدد التخصصات، تثقيف المرضى