

Nutritional Intervention for Active Tuberculosis: Relevance to Nunavut Tuberculosis Control and Elimination Program

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Abstract

Introduction: A Canadian physician named Sir William Osler truly stated that “Tuberculosis (TB) is a social disease with a medical aspect.” The social determinants of health including food insecurity and malnutrition play a critical role in the high TB incidence in Nunavut, especially among Inuit. The rising epidemiology of TB indicates a strong need for improving the nutritional status of Inuit towards prevention of initial, recurrent infections and immune deficiencies.

Methods: The author conducted a small, two-stage analysis of tuberculosis epidemiology and nutritional status in individuals of Inuit ancestry. The first stage included the review of the currently available literature associated with the prevalence of TB in Canada, with a focus on Inuit, and its healthcare expenditure. The second phase focused on assessment of the missing nutrition link in treatment and prevention of the infectious epidemic.

Results: The analysis showed that there is a lack of nutrition driven strategies to combat TB incidence among Inuit. There is a compelling need to develop a strategy to fight TB by employing strategies to elevate overall nutritional and health status. The Inuit population continues to face the high incidence of the disease, and we need to remain plugged into efforts to eradicate it.

Conclusion: The lack of nutrition among Inuit leads to primary and recurrent TB infections. This commentary recognizes malnutrition and compromised nutritional status as a cardinal feature of TB epidemiology and strongly advocates the initiation of a program targeting this risk of TB.

Keywords: Tuberculosis; Nutrition; Nunavut; Health policy; Global health; Indigenous health

Introduction

Tuberculosis (TB), an infectious disease caused by *Mycobacterium tuberculosis*, is still a global public health issue and the second leading cause of mortality from an infectious disease following HIV/AIDS worldwide [1]. Apart from 1.4 million TB-related deaths every year, the emergence of multi-drug-resistant and extensively drug-resistant TB, further threatens the public health around the globe including Canada [1,2]. The Public Health Agency of Canada (PHAC) through the Canadian Tuberculosis Reporting System (CTBRS) maintains the individual-level TB data from all Canadian provinces and territories. In 2013, PHAC reported the overall decrease in the occurrence of TB among Canadians, but the incidence of TB in Nunavut (northernmost territory of Canada), particularly among Inuit is escalating at a concerning pace [3]. The TB prevalence rate among Inuit is around 250 times higher than the Canadian-born non-aboriginals [4]. A 2014 assessment estimates overall 106.1 incidents of TB infections per 100,000 populations in Northern territories, the demographical stronghold of Inuit people. However, these numbers are only 0.7 per 100,000 populations in Prince Edward Island. The Social Determinants of Health, including food insecurity and malnutrition, may contribute to this discrepancy between Canada's overall TB incidence and that of Inuit in Nunavut [5]. An effective preventive approach to the TB and

malnutrition issues in Nunavut, especially in the Inuit context, requires a scientific and evidence-based strategy that recognizes and mitigates both social and economic influences.

Malnutrition among Nunavut Resident: Facts and Challenges

As malnutrition may recurrently predispose Inuit to the development of secondary immunodeficiency and increased risk of progression to active TB, the potential role of dietary supplementation should be considered to improve the compromised immunity and nutrition status. Currently, the Nunavut's Inuit population suffers from the severe deficiency of vitamins, minerals and dietary antioxidants including vitamins A, folic acid, C, D, E, riboflavin, magnesium, fibre, n-6 fatty acids, and calcium [6,7]. The food insecurity and acute deficiency of micronutrients are highly predictive of the low life expectancy, anaemia prevalence and the three-fold higher rate of infant mortality among Inuit compared to Canadian-born non-aboriginals [7]. The isolated Inuit communities also face food shortage due to the harsh climate, fuel costs, narrow window for hunt/harvest, shrinking flora and fauna, and a few retail food store options to obtain the adequate and culturally acceptable nutritious food [8]. The Government of Nunavut's Department of Health and Social Services along with the Aboriginal Affairs and Northern Development Canada recognize the relation between malnutrition and TB epidemic. Yet, detailed data on the Inuit diet is not available, thus posing additional

hurdles to restore the adequate nutrition status in Nunavut TB patients. Another fundamental challenge to eradicating this disease is dealing with latent TB infection, usually supported by poor nutrition. Nunavut residents, particularly Inuit have low to medium income, high unemployment rate and the market foods with a high nutritional value are very costly [5-7]. Therefore, it may be an appropriate measure to introduce dietary supplementation protocol to combat malnutrition and improve the nutrition status.

Nunavut TB Plan and the Missing Nutrition Link

Although it's hard to assess the effect of nutrition on tuberculosis as multifaceted and parallel environmental factors are involved. The weight of epidemiological evidence favours the opinion that improvement of nutritional status can decrease the mortality and morbidity associated in tuberculosis patients, especially in those subjected to the shortage of nutritious food. The prevention and treatment of TB are a strategic focus for both federal and provincial governments in Canada, as they aim to develop a plan to reduce TB incidence rates, avoid repeated infections and improve the treatment outcomes. In 2013, July/August issue of *Canadian Respiratory Journal* (the official journal of the Canadian Thoracic Society), various scientists gave a detailed report regarding the epidemiology of TB in Canada, and pointed out the malnutrition as a crucial proximate risk factor for TB infection and its reactivation along with parallel occurrence of anaemia [9]. Therefore, addressing the malnutrition challenge especially among Inuit should be a crucial strategic target in Canada's policy towards reaching TB elimination targets set by the World Health Organization (WHO) and the Global Plan to Stop TB. Both the evaluation of nutrition status and attenuation of malnutrition among Inuit are missing in the Nunavut TB program. This is surprising as studies in rural Africa assess the nutritional status in TB patients, as a part of their TB eradication program [10]. The widespread malnutrition and a missing plan to restore healthy nutrition status among Nunavut's TB patients is a major challenge towards Canada's goal for TB elimination.

The oxidative stress, uncontrolled lipid peroxidation, inflammation and protein oxidation are widely reported in all categories of TB and may be associated with worse clinical outcomes [10,11]. As nutritional impairment may predispose Inuit to aggressive TB pathology; it is essential to understand the potential of nutritional intervention and dietary supplementation in TB therapy. Several clinical studies have confirmed the altered redox homeostasis in TB patients, and its attenuation using dietary intervention. A clinical trial in India with advanced pulmonary TB patients showed that a cocktail of dietary antioxidants (vitamins and minerals) acted as an adjuvant therapy, helped to reduce oxidative stress and promoted the recovery of patients [11]. Similarly, a randomized, double-blind, placebo-controlled trial of micronutrients (vitamins A, B-complex, C, E, and selenium) in TB-HIV co-infected Tanzanian patients showed that these micronutrients decreased the risk of TB recurrence by 45% overall [12]. Interestingly, the micronutrient (antioxidant) supplementation has also demonstrated the ability to improve the effectiveness of standard anti-tuberculosis drugs, thereby exhibiting the synergistic therapeutic effect [13]. Overall, the micronutrients, with their therapeutic and antioxidant functions, protect TB patients from the bacterium attack, promote healthy nutrition status and improve disease resistance.

Initiating Nutritional Intervention in Nunavut

In Canada, the cost of TB treatment equates to \$47,290 for an active TB case, while treating one multidrug-resistant case costs between \$41,225-195,078 for outpatients and inpatients respectively [14]. In the light of the heavy economic burden of TB incidence on Canadian health system, avoiding repetitive TB infection and elevating nutritional status, presents itself as a crucial strategic measure. A biphasic plan is recommended which includes the estimation of nutrition/antioxidant status of the general Inuit population and TB patients in Nunavut. It can be achieved by measuring the levels of dietary micronutrient intake along with the measurement of plasma lipids, antioxidant status, BMI, vitamin concentration, total protein and albumin in plasma of the patients. In the second phase, a randomized controlled trial of nutritional supplementation to assess the effects of nutritional intervention on the nutritional status and physical function in patients with TB is proposed. The nutritional supplementation trial can include all the vitamins and micronutrients/antioxidants, usually deficient in Inuit TB patients. From the perspective of methodological rigor, much of the evidence from the second phase will be strong and shall help to determine the adequate micronutrient supplementation required for Inuit TB patients. Based on data from studies mentioned above, the adequate nutritional supplementation can certainly diminish the pathological influences, the incidence and the severity of tuberculosis among Inuit. Overall, a follow-up on the WHO recommendations on nutritional intervention in TB by an initial assessment of nutritional status, appropriate counseling based on the nutritional status at diagnosis followed by nutritional intervention in TB patients may help in improving the Inuit health [15,16].

Conclusions and recommendations

The impact of malnutrition on cellular immune function and TB reactivation cannot be underestimated. For the successful execution of this plan, three central questions need to be addressed. Has nutritional intervention decreased the predisposition and recurrence of tuberculosis infection? Has nutritional intervention influenced or modified the progression of primary tuberculosis infection? Has nutritional intervention changed and improved the response to clinical therapy? Without the appropriate knowledge of the nutritional status of Inuit TB patients, it is not possible to develop a nutrition intervention plan for aiming at reduced TB incidence. The Public Health Agency of Canada through the Canadian Tuberculosis Reporting System has initiated multiple programs for eliminating TB in Canada, but without malnutrition aimed plan, the TB incidence among Nunavut's only will rise indefinitely. It is also important to mention that there is only slight increase of total Canadian TB cases from a total of 1,639 cases in 2015, from the number 1,1614 cases reported in 2014 [17]. However, it might be due to lack of reporting or due to infections in latency period. To conclude, two recommendations are presented that may begin to address the challenges in Nunavut TB program and whose effectiveness remains limited. First, a plan for the assessment of nutritional status among Inuit, dietary counselling, and a reach out awareness program, in both research and practice. Second, the development of a novel dietary supplementation plan for Inuit to combat compromised immune function and nutrition status. Doing so may begin from considering results from assessment trials (phase I) and by following the outline of previous clinical trials, and a follow-up study on the effect of supplementation of dietary micronutrients/antioxidants. Review of nutritional rehabilitation in TB patients

suggests the use of micronutrients such as zinc, vitamins A, D, C, E, selenium, iron, copper, omega-6 fatty acids, and omega-3 fatty acids [18]. Finally, availability of fresh food via year-round greenhouse projects can certainly improve the diet of Inuit and aid their nutritional rehabilitation. Such plan must keep in account the frail yet concerning the possibility of low drug bioavailability due to drug-food interactions in TB patients [19]. Overall, these strategies can certainly help Nunavut government's Nunavut Nutrition program aiming to improve health and nutritional status of the territorial population (available at <http://www.livehealthy.gov.nu.ca/en/food-0>). This plan is particularly important when thinking about Canada's overall public health status, especially in the context of marginalized Inuit communities as it may help us guard against both health and economic challenges posed by TB. In Canada, TB control is a shared responsibility among health agencies, researchers, governments, patients and civil society; so, it is time now for all to act together.

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