



# SEVERE MALNUTRITION IN AN ELDERLY PATIENT WITH PULMONARY TUBERCULOSIS: A CASE REPORT

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## ABSTRACT

### Introduction

Undernutrition is the single largest population-attributable risk factor for tuberculosis worldwide, and the relationship between the two conditions is bidirectional: nutritional depletion impairs cell-mediated immunity and permits progression to active disease, while active disease drives anorexia, hypermetabolism and accelerated loss of lean tissue. In older adults this interaction is compounded by immunosenescence, inflammaging and the anorexia of ageing, yet the geriatric population remains under-represented in both tuberculosis and clinical nutrition literature. Severe undernutrition at the extreme end of the spectrum, with a body mass index below 14 kg/m<sup>2</sup>, is encountered principally in resource-constrained primary care settings where formal nutritional assessment is seldom performed.<sup>1-3</sup>

### Case Illustration

A 73-year-old male farmer presented to a community health centre with one month of productive cough accompanied by rhinorrhoea and exertional breathlessness. Fever and night sweats were absent. He described progressive unintentional weight loss and a one-week decline in appetite, and had smoked ten cigarettes daily for many years. Vital signs were within normal limits, but he appeared cachectic, weighing 40 kg at a height of 170 cm, giving a body mass index of 13.8 kg/m<sup>2</sup>, with a mid-upper arm circumference of 23 cm and a waist circumference of 70 cm. Sputum nucleic acid amplification testing detected *Mycobacterium tuberculosis*; random blood glucose was 92 mg/dL and human immunodeficiency virus serology was non-reactive. The Mini Nutritional Assessment yielded a total score of 15.5 of 30, placing him in the malnourished category, and simplified geriatric screening confirmed impairment confined to the nutrition domain. He was commenced on a standard six-month antituberculosis regimen together with symptomatic therapy, and a structured, stepwise nutritional prescription with refeeding precautions was formulated.<sup>4,5</sup>

### Discussion

This case demonstrates the convergence of four distinct but overlapping constructs in a single patient: protein-energy malnutrition satisfying the Global Leadership Initiative on Malnutrition criteria, disease-related malnutrition with inflammation consistent with cachexia, probable sarcopenia, and the anorexia of ageing. The discussion examines why chronological ageing predisposes to both tuberculosis and nutritional depletion, the discordance observed between body mass index and mid-upper arm circumference in this patient, the

derivation of individualised energy and protein targets, the stratification and prevention of refeeding syndrome, the influence of low body weight on antituberculosis drug exposure, and the evidence that nutritional support materially improves tuberculosis outcomes. A discrepancy between the recorded fixed-dose combination tablet number and the patient's weight band is also examined, since it carries direct implications for toxicity in an older adult.<sup>6-8</sup>

### **Conclusion**

Severe undernutrition in an older adult with pulmonary tuberculosis is not a passive comorbidity but a modifiable determinant of survival, treatment success and functional recovery. Nutritional status should be quantified with validated instruments at the point of diagnosis, a numerically explicit and phased nutritional prescription should be issued alongside chemotherapy rather than after it, and drug dosing should be re-verified against actual body weight. Primary care services in high-burden settings are the appropriate place for this integrated assessment to occur.<sup>9</sup>

### **Keywords**

Pulmonary tuberculosis; severe undernutrition; older adults; cachexia; nutritional assessment

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## INTRODUCTION

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### Background

Tuberculosis remains among the foremost infectious causes of death globally, and progress towards elimination targets has been markedly uneven across age strata. Analyses of global burden data covering the period to 2021 demonstrate that while incidence and mortality declined substantially in children and younger adults, the rate of decline in those aged fifty years and above was considerably slower, and in the oldest group mortality reduction was minimal. The demographic transition now under way in South-East Asia and the Western Pacific means that the absolute number of older adults at risk is expanding at precisely the moment when programmatic attention has been concentrated elsewhere. Older adults are more likely to acquire disease through reactivation of latent infection, more likely to present atypically, and more likely to die during treatment than their younger counterparts.<sup>3,10,11</sup>

Running in parallel with this demographic shift is a nutritional one. Undernutrition is the leading population-level risk factor for tuberculosis, exceeding in attributable fraction the contributions of human immunodeficiency virus infection, diabetes, alcohol and tobacco. Recent modelling suggests that the population attributable fraction conventionally cited may itself be a substantial underestimate, with elimination of adult undernutrition potentially averting close to a quarter of adult tuberculosis incidence worldwide. The mechanism is an acquired, potentially reversible immunodeficiency: deficiencies of energy, protein and specific micronutrients impair macrophage effector function, granuloma integrity and T-helper-1 responses, permitting containment of *Mycobacterium tuberculosis* to fail.<sup>1,2,12</sup>

The relationship operates in both directions, and it is this bidirectionality that makes the syndemic so difficult to interrupt. Active tuberculosis suppresses appetite, increases resting energy expenditure, alters intermediary metabolism and may impair nutrient absorption, so that a patient who was already nutritionally marginal at the point of infection deteriorates rapidly once disease becomes manifest. Cross-sectional data from high-burden settings consistently show that a large

proportion of patients are already undernourished at the moment of diagnosis, with severe undernutrition present in a substantial minority.<sup>13-16</sup>

The clinical consequences of this nutritional deficit are not merely anthropometric. Undernutrition at diagnosis is associated with more extensive radiographic disease and a greater likelihood of cavitation, with delayed sputum conversion, with roughly a doubling of the risk of unsuccessful treatment outcome, and with a two-fold or greater increase in the risk of death during therapy. Severe undernutrition confers the steepest gradient of risk, and a substantial proportion of patients who begin treatment underweight remain so at its completion, carrying a persistently elevated hazard of relapse.<sup>17-19</sup>

In the older patient, three additional physiological processes are superimposed on this picture. Immunosenescence and the low-grade sterile inflammatory state termed inflammaging degrade the capacity to mount and sustain an effective anti-mycobacterial response. The anorexia of ageing, mediated through altered gut hormone signalling, delayed gastric emptying, reduced central orexigenic drive and diminished chemosensory function, reduces habitual intake independently of disease. Sarcopenia depletes the skeletal muscle reservoir from which amino acids are mobilised during catabolic stress, narrowing physiological reserve before any illness supervenes. The European Society for Clinical Nutrition and Metabolism accordingly recommends that every older person be screened routinely for malnutrition, and that nutritional intervention be individualised, comprehensive and delivered within a multidisciplinary framework.<sup>20-23</sup>

That nutritional support is not merely supportive but therapeutically consequential has now been demonstrated in a randomised setting. In the RATIONS cluster-randomised trial conducted in Jharkhand, India, provision of monthly food rations to household contacts of patients with microbiologically confirmed pulmonary tuberculosis reduced incident tuberculosis by between thirty-nine and forty-eight per cent over two years of follow-up. Within the patient cohort nested in the same trial, in which more than four-fifths were underweight at enrolment and roughly one in six had a body mass index below 14 kg/m<sup>2</sup>, achievement of a five per cent weight gain during the first two months of therapy was associated with a sixty-one per cent reduction in the hazard of tuberculosis death. A recent Health Policy statement has translated these findings into an

operational roadmap for embedding nutritional assessment, counselling and support within routine tuberculosis care.<sup>8,9,24</sup>

The instruments required to implement such an approach are neither expensive nor technically demanding. The Mini Nutritional Assessment has been validated across community, hospital, rehabilitation and residential settings, is specifically constructed for geriatric use, and requires only a tape measure, weighing scales and a structured interview. In Indonesia, the simplified elderly screening instrument known as SKILAS operationalises the World Health Organization Integrated Care for Older People framework at primary care level, screening the domains of cognition, locomotion, nutrition, vision, hearing and psychological state. Both instruments are deployable in a community health centre by a single clinician.<sup>5,25,26</sup>

### **Objectives**

The general objective of this report is to describe, in comprehensive detail, the clinical presentation, diagnostic evaluation, nutritional characterisation and integrated management of severe undernutrition occurring in an older adult with newly diagnosed, microbiologically confirmed pulmonary tuberculosis in an Indonesian primary care setting.

The specific objectives are as follows. First, to document the systematic application of validated nutritional and geriatric screening instruments, namely the Mini Nutritional Assessment and the SKILAS instrument, in a patient encountered at community health centre level. Second, to demonstrate the derivation of an individualised, numerically explicit and phased energy and protein prescription from the patient's measured anthropometry. Third, to set out a structured strategy for the recognition and prevention of refeeding syndrome in a patient at the highest stratum of risk. Fourth, to examine the pharmacological implications of very low body weight for antituberculosis drug exposure and toxicity in an older adult. Fifth, to situate the case within the contemporary evidence base linking nutritional status, nutritional intervention and tuberculosis outcomes.

### **Benefits of the Report**

The theoretical benefit lies in the integration of four conceptually distinct but clinically overlapping constructs, namely malnutrition, cachexia, sarcopenia and the anorexia of ageing,

within a single well-characterised patient, thereby clarifying where the definitions converge and where they must be kept separate.

The clinical benefit lies in providing practitioners with an explicit, reproducible worked example of nutritional assessment and prescription in severe undernutrition, including the arithmetic of energy and protein targets and the sequencing of refeeding, together with an examination of a dosing discrepancy of a kind that is easily overlooked in routine practice.

The programmatic benefit lies in demonstrating that a complete nutritional and geriatric assessment is feasible at community health centre level using instruments already available within the Indonesian primary care system, and in supporting the argument that nutritional care should be a formally reported component of national tuberculosis programme activity rather than an informal adjunct.<sup>9</sup>

### **Hypotheses**

This report is framed around three working propositions, which a case report can illustrate and render plausible but cannot formally test.

The first is that in an older adult with pulmonary tuberculosis, severe undernutrition is the product of a self-reinforcing cycle in which age-related physiological change, chronic dietary inadequacy, mycobacterial disease and systemic inflammation each amplify the others, such that intervention directed at only one limb of the cycle will be insufficient.<sup>14,27</sup>

The second is that reliance on any single anthropometric index will misclassify the severity or the nature of nutritional depletion, and that concurrent measurement of body mass index, mid-upper arm circumference and a multidimensional screening score yields a materially different and more actionable clinical picture than any one of them alone.<sup>28,29</sup>

The third is that structured nutritional therapy delivered concurrently with, rather than subsequent to, antituberculosis chemotherapy is associated with improved treatment outcomes, and that early weight gain functions as an accessible surrogate marker of that improvement.<sup>8</sup>

### **Research Gap**

Three gaps in the existing literature motivate this report. The first concerns the age distribution of the evidence base. The landmark nutritional intervention studies in tuberculosis,

including the RATIONS trial and the rural Indian cohorts that preceded it, enrolled populations with mean ages in the fifth decade, and older adults constitute a small and incompletely described subgroup within them. Comparative data from South India confirm that elderly patients experience significantly higher rates of unfavourable outcome and death than non-elderly patients, yet targeted nutritional evidence for this group remains sparse.<sup>19,24,30</sup>

The second concerns the quality of nutritional characterisation in tuberculosis research and practice. A systematic review of malnutrition assessment methods in adults with tuberculosis identified that in more than three-quarters of published studies, body mass index was the only index applied, and that fewer than one study in twenty captured all three domains of the accepted conceptual definition of malnutrition, namely intake or assimilation, body composition, and physical or cognitive function. Nutritional status in tuberculosis is therefore usually described by a single number that conveys nothing about muscle mass or function.<sup>28</sup>

The third concerns the absence of published guidance on how nutritional and geriatric screening should be operationally combined in a primary care encounter. Studies evaluating the Mini Nutritional Assessment in older adults with pulmonary tuberculosis have established that abnormal nutritional status is highly prevalent and correlates with measures of balance and lower-limb function, but have not addressed how such screening should be linked to a specific, calculated nutritional prescription at the point of care.<sup>31</sup>

### **Novelty of the Report**

The novelty of this report resides in four elements. It documents severe undernutrition at an unusually extreme degree, a body mass index of 13.8 kg/m<sup>2</sup>, in an older adult managed entirely within primary care rather than in a referral hospital, a setting from which detailed nutritional case documentation is rarely published.

It reports the concurrent application of a validated geriatric nutritional instrument and an intrinsic-capacity screening instrument in the same patient at the same encounter, and demonstrates how the two yield complementary rather than redundant information.

It presents an explicit, day-by-day refeeding schedule derived arithmetically from the patient's own measured weight, rather than a general recommendation to improve nutritional intake, and pairs it with a defined biochemical monitoring plan.

Finally, it identifies and analyses a discrepancy between the recorded number of fixed-dose combination tablets and the number indicated by the patient's weight band, a pharmacological consideration of direct relevance to hepatotoxicity and ocular toxicity in an older adult with very low body weight, and one that is seldom examined in published tuberculosis case reports.<sup>32,33</sup>

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### CASE ILLUSTRATION

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#### Presenting Complaint and History of Present Illness

A 73-year-old man presented to a community health centre with a productive cough that had been present for approximately one month. The cough was accompanied by rhinorrhoea and by breathlessness on exertion. He specifically denied fever and denied night sweats. He reported that his body weight had been falling progressively over the preceding period, and that over the last week his appetite had declined further. He had not previously sought medical attention for these symptoms.

The absence of fever and night sweats is noteworthy. These two symptoms are conventionally regarded as cardinal features of pulmonary tuberculosis, and their absence in an older adult is a recognised contributor to delayed presentation and delayed clinical suspicion. In this patient the presenting complex was dominated by respiratory symptoms and constitutional wasting rather than by the classical febrile syndrome.<sup>34,35</sup>

#### Past, Family and Social History

There was no history of diabetes mellitus and no history of hypertension. Neither the patient nor any family member had previously received antituberculosis chemotherapy, and no household member reported similar symptoms, so that no source case could be identified. He had smoked ten cigarettes daily and worked as a farmer. The complete risk-factor profile is summarised in Table 1.

**Table 1. Demographic profile and inventory of tuberculosis and nutritional risk factors**

| Domain | Finding | Clinical significance |
|--------|---------|-----------------------|
|--------|---------|-----------------------|

|                                   |                                              |                                                                                                                        |
|-----------------------------------|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Age                               | 73 years                                     | Reactivation risk rises with age; immunosenescence and inflammaging impair mycobacterial containment                   |
| Sex                               | Male                                         | Male sex is consistently associated with higher tuberculosis incidence and with elderly tuberculosis in particular     |
| Occupation                        | Farmer                                       | Rural agricultural work is associated with delayed care-seeking and with lower household food security                 |
| Tobacco use                       | 10 cigarettes daily                          | Approximately doubles the risk of tuberculosis disease and of tuberculosis death; impairs alveolar macrophage function |
| Diabetes mellitus                 | Denied; random glucose 92 mg/dL              | Important competing risk factor excluded on history and on point-of-care testing                                       |
| Hypertension                      | Denied                                       | No competing cardiovascular contribution to weight loss identified                                                     |
| Previous antituberculosis therapy | None, in patient or family                   | Supports classification as a new case; reduces prior probability of acquired drug resistance                           |
| Household contacts                | No symptomatic contacts identified           | No index source case; contact investigation nonetheless indicated                                                      |
| Habitual diet                     | Rice, small quantity of vegetables, sea fish | Energy-dilute, monotonous pattern of low protein and micronutrient density                                             |
| Appetite                          | Declining over the preceding week            | Anorexia is both a disease effect and an age-related phenomenon                                                        |

|                   |                                |                                                        |
|-------------------|--------------------------------|--------------------------------------------------------|
| Weight trajectory | Progressive unintentional loss | Phenotypic criterion for malnutrition and for cachexia |
|-------------------|--------------------------------|--------------------------------------------------------|

### Nutritional History

The habitual diet consisted of rice as the dominant staple, a small quantity of vegetables, and sea fish. No quantified dietary recall or food-frequency assessment was performed at the index consultation, so no numerical estimate of habitual energy or protein intake is available; the pattern is therefore described qualitatively. Even so, the described pattern is characteristic of an energy-dilute and monotonous diet in which protein density and micronutrient variety are both limited, and it is consistent with the low protein-marker score recorded on formal nutritional assessment. The superimposed one-week decline in appetite indicates an acute reduction below an intake that was already chronically marginal.

This distinction between chronic dietary inadequacy and acute anorexia is clinically important, because the two carry different implications. Chronic inadequacy produces the depleted body compartment reflected in the anthropometry, whereas acute anorexia signals the catabolic activity of the disease itself and is the component most likely to respond promptly to effective chemotherapy.<sup>13,36</sup>

### Physical Examination

Vital signs were documented as being within normal limits. General inspection revealed a visibly thin and wasted patient. The examination findings and their interpretation are presented in Table 2.

**Table 2. Physical examination findings at presentation**

| Parameter            | Finding              | Interpretation                                                       |
|----------------------|----------------------|----------------------------------------------------------------------|
| Vital signs          | Within normal limits | Haemodynamically stable; no criteria for immediate referral          |
| General appearance   | Thin, visibly wasted | Clinically evident depletion of subcutaneous fat and skeletal muscle |
| Respiratory symptoms | Productive cough,    | Consistent with parenchymal                                          |

|                         |                                   |                                                                        |
|-------------------------|-----------------------------------|------------------------------------------------------------------------|
|                         | rhinorrhoea, exertional dyspnoea  | pulmonary involvement                                                  |
| Constitutional symptoms | Fever absent; night sweats absent | Atypical, age-associated presentation                                  |
| Appetite                | Reduced over one week             | Aetiological criterion under the GLIM framework                        |
| Oedema                  | Not documented                    | Relevant to interpretation of body weight; ideally recorded explicitly |

### Anthropometry and Derived Nutritional Indices

Body weight was 40 kg and height 170 cm, giving a body mass index of 13.8 kg/m<sup>2</sup>. Mid-upper arm circumference measured 23 cm and waist circumference 70 cm. Applying the modified Broca formula, ideal body weight for this height is approximately 63 kg, so that actual weight represented approximately 64 per cent of ideal. To reach the lower boundary of the normal body mass index range would require a weight gain of approximately 13.5 kg, and to reach the mid-normal range approximately 23.6 kg. The full set of measurements and derived indices is presented in Table 3, and the patient's position relative to accepted thresholds is displayed graphically in Figure 1.

**Table 3. Anthropometric measurements and derived nutritional indices**

| Index           | Value                  | Reference threshold     | Classification                                                                   |
|-----------------|------------------------|-------------------------|----------------------------------------------------------------------------------|
| Body weight     | 40 kg                  | —                       | Approximately 64% of ideal body weight                                           |
| Height          | 170 cm                 | —                       | —                                                                                |
| Body mass index | 13.8 kg/m <sup>2</sup> | ≥18.5 kg/m <sup>2</sup> | Severe undernutrition (well below the 16.0 kg/m <sup>2</sup> severity threshold) |
| Mid-upper arm   | 23 cm                  | ≥25 cm in men           | Reduced; corresponds                                                             |

|                                          |                              |                                     |                                                                   |
|------------------------------------------|------------------------------|-------------------------------------|-------------------------------------------------------------------|
| circumference                            |                              |                                     | approximately to a body mass index below 17 kg/m <sup>2</sup>     |
| Calf circumference                       | Below 31 cm (not quantified) | ≥31 cm                              | Reduced; supports diminished appendicular muscle mass             |
| Waist circumference                      | 70 cm                        | No undernutrition threshold defined | Consistent with depleted visceral and subcutaneous adipose tissue |
| Ideal body weight (modified Broca)       | Approximately 63 kg          | —                                   | Deficit of approximately 23 kg                                    |
| Weight required for body mass index 18.5 | Approximately 53.5 kg        | —                                   | Gain of approximately 13.5 kg required                            |

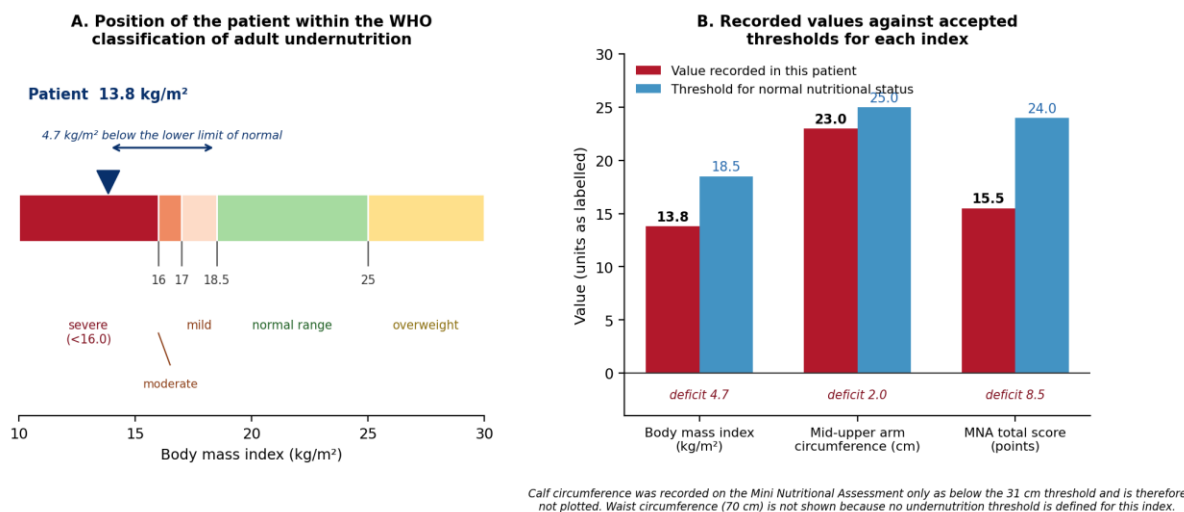


Figure 1. Panel A shows the position of the patient within the World Health Organization classification of adult undernutrition. Panel B compares each recorded index against its accepted threshold. Calf circumference is omitted because it was recorded only as being below the 31 cm cut-off.

## Laboratory and Microbiological Investigations

Sputum was submitted for cartridge-based nucleic acid amplification testing, which detected *Mycobacterium tuberculosis*. Random blood glucose was 92 mg/dL and human immunodeficiency virus serology was non-reactive. Results are summarised in Table 4.

**Table 4. Laboratory and microbiological results**

| Investigation                          | Result                                     | Interpretation                                                                                                                           |
|----------------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Sputum nucleic acid amplification test | <i>Mycobacterium tuberculosis</i> detected | Bacteriologically confirmed pulmonary tuberculosis; rifampicin susceptibility result not documented in the record and requires retrieval |
| Random blood glucose                   | 92 mg/dL                                   | No evidence of diabetes mellitus, an important competing risk factor and determinant of poor outcome                                     |
| Human immunodeficiency virus serology  | Non-reactive                               | Excludes the principal alternative cause of severe wasting in this context                                                               |
| Full blood count                       | Not performed                              | Haemoglobin is recommended at baseline; anaemia predicts wasting and disease severity                                                    |
| Liver function tests                   | Not performed                              | Relevant to hepatotoxicity risk in an older, undernourished patient                                                                      |
| Serum albumin                          | Not performed                              | Would have supported characterisation of visceral protein status                                                                         |
| Electrolytes, phosphate, magnesium     | Not performed                              | Required for refeeding risk stratification and monitoring                                                                                |
| Chest radiography                      | Not documented                             | Would have permitted assessment of disease extent and cavitation                                                                         |

Several of these omissions merit comment rather than criticism, since they reflect the realistic diagnostic capability of a community health centre. Nonetheless, baseline haemoglobin is explicitly recommended within contemporary nutritional care frameworks for tuberculosis, because anaemia is strongly associated with wasting, greater disease severity and slower clinical recovery, and because it independently predicts tuberculosis mortality. Baseline electrolytes, phosphate and magnesium acquire particular importance in this patient because of his refeeding risk stratum.<sup>8,9,37</sup>

### **Formal Nutritional Assessment: Mini Nutritional Assessment**

The full Mini Nutritional Assessment was administered. The screening section yielded 7 of a possible 14 points, which alone places the patient in the malnourished category and mandates completion of the assessment section. The assessment section yielded 8.5 of a possible 16 points, giving a total score of 15.5 of 30. A total below 17 points defines malnutrition, so the patient falls clearly within that category rather than at the boundary of nutritional risk. The completed instrument is reproduced as Figure 2, and the screening items are itemised in Table 5.

**Table 5. Mini Nutritional Assessment screening section, item-by-item**

| Item | Domain assessed                                                                                                                           | Score | Maximum |
|------|-------------------------------------------------------------------------------------------------------------------------------------------|-------|---------|
| A    | Decline in food intake over the preceding three months owing to loss of appetite, digestive difficulty, or chewing or swallowing problems | 1     | 2       |
| B    | Weight loss during the preceding three months                                                                                             | 0     | 3       |
| C    | Mobility                                                                                                                                  | 2     | 2       |
| D    | Psychological stress or acute illness in the preceding three months                                                                       | 2     | 2       |
| E    | Neuropsychological problems                                                                                                               | 2     | 2       |
| F    | Body mass index                                                                                                                           | 0     | 3       |
| —    | Screening subtotal (12–14 normal; 8–11 at risk; 0–7 malnourished)                                                                         | 7     | 14      |
| —    | Assessment subtotal (items G to R)                                                                                                        | 8.5   | 16      |

|   |                                                                                             |      |    |
|---|---------------------------------------------------------------------------------------------|------|----|
| — | Total Mini Nutritional Assessment score ( $\geq 17$ to 23.5 at risk; below 17 malnourished) | 15.5 | 30 |
|---|---------------------------------------------------------------------------------------------|------|----|

Two features of the screening profile deserve emphasis. Item B scored zero, indicating documented weight loss exceeding three kilograms over three months, and item F scored zero, reflecting a body mass index below 19 kg/m<sup>2</sup>. These are the two items that carry the greatest weight within the instrument, and both were maximally abnormal. By contrast, items C, D and E scored full marks, indicating preserved mobility, no recognised acute psychological stressor and no neuropsychological impairment. The nutritional deficit in this patient is therefore not attributable to immobility, to dementia or to depression, which are the three most common non-disease drivers of undernutrition in older adults. Within the assessment section, the recorded findings included a low protein-marker score, a self-perception of impaired nutritional status, a mid-upper arm circumference above the 22 cm cut-off, and a calf circumference below the 31 cm cut-off.

## Mini Nutritional Assessment

### MNA®

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Nama belakang: \_\_\_\_\_ Nama depan: [redacted]

Jenis kelamin: L Usia: 73 th Berat badan: 40 kg Tinggi badan: 170 cm Tanggal: \_\_\_\_\_

Lengkapi skrining berikut dengan mengisi kotak yang tersedia dengan angka yang sesuai. Jumlahkan seluruh angka untuk memperoleh skor skrining. Jika skor bernilai 11 atau lebih kecil, lanjutkan ke penilaian untuk memperoleh Skor Indikator Malnutrisi.

| Skrining                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| <b>A Apakah asupan makanan berkurang selama 3 bulan terakhir karena kehilangan nafsu makan, gangguan pencernaan, atau kesulitan mengunyah atau menelan?</b><br>0 = Asupan makanan sangat berkurang<br>1 = Asupan makanan agak berkurang<br>2 = Asupan makanan tidak berkurang                                                                                                                                                                                                                                                                                                                                                                              | 1 |
| <b>B Berat badan turun selama 3 bulan terakhir?</b><br>0 = Berat badan turun lebih dari 3 kg (6,6 pon)<br>1 = Tidak tahu<br>2 = Berat badan turun antara 1 hingga 3 kg (2,2 hingga 6,6 pon)<br>3 = Berat badan tidak turun                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 |
| <b>C Pergerakan atau Mobilitas?</b><br>0 = Terbatas di tempat tidur atau kursi<br>1 = Mampu bangun dari tempat tidur/kursi, tetapi tidak dapat bepergian ke luar rumah<br>2 = Dapat bepergian ke luar rumah                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2 |
| <b>D Mengalami tekanan psikologis atau penyakit akut dalam 3 bulan terakhir?</b><br>0 = Ya 2 = Tidak                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2 |
| <b>E Gangguan neuropsikologis</b><br>0 = Demensia berat atau depresi<br>1 = Demensia ringan<br>2 = Tidak ada gangguan psikologis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2 |
| <b>F Indeks Massa Tubuh (IMT) = (berat badan dalam kg)/(tinggi badan dalam m)<sup>2</sup></b><br>0 = IMT kurang dari 19<br>1 = IMT 19 hingga kurang dari 21<br>2 = IMT 21 hingga kurang dari 23<br>3 = IMT 23 atau lebih besar                                                                                                                                                                                                                                                                                                                                                                                                                             | 0 |
| <b>Skor Skrining (Subtotal maks. 14 poin)</b><br>12-14 poin: Status gizi normal<br>8-11 poin: Berisiko mengalami malnutrisi<br>0-7 poin: Malnutrisi<br>Untuk penilaian yang lebih mendalam, lanjutkan ke pertanyaan G-R.                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |
| <b>Penilaian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |
| <b>G Mampu merawat diri sendiri (tidak di panti werdha atau rumah sakit)</b><br>1 = Ya 0 = Tidak                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0 |
| <b>H Mengonsumsi lebih dari 3 obat resep setiap hari</b><br>0 = Ya 1 = Tidak                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1 |
| <b>I Luka tekan atau borok kulit</b><br>0 = Ya 1 = Tidak                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1 |
| <b>Daftar Pustaka</b><br>1. Velaz B, Villars H, Abellan G, et al. Overview of the MNA® - Its History and Challenges. <i>J Nutr Health Aging</i> 2006; 10:466-465.<br>2. Rubenstein LZ, Harker JO, Saliva A, Guigo Y, Velaz B. Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini Nutritional Assessment (MNA-SF). <i>J Geront</i> 2001; 56A: M366-377.<br>3. Guigo Y. The Mini-Nutritional Assessment (MNA®) Review of the Literature - What does it tell us? <i>J Nutr Health Aging</i> 2006; 10:466-487.<br>© Société des Produits Nestlé SA, Trademark Owners.<br>© Société des Produits Nestlé SA 1994, Revision 2009. |   |
| Untuk informasi selengkapnya, kunjungi <a href="http://www.mna-elderly.com">www.mna-elderly.com</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |

|                                                                                                                                                                                                                                                                                                                                       |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>J Berapa kali pasien mengonsumsi makan lengkap setiap hari?</b><br>0 = 1 kali<br>1 = 2 kali<br>2 = 3 kali                                                                                                                                                                                                                          | 2    |
| <b>K Penanda konsumsi terpilih untuk asupan protein</b><br>• Setidaknya satu porsi produk susu (susu, keju, yogurt) setiap hari<br>• Dua porsi atau lebih kacang-kacangan atau telur setiap minggu<br>• Daging, ikan, atau unggas setiap hari<br>0,0 = Jika 0 atau 1 jawaban ya<br>0,5 = Jika 2 jawaban ya<br>1,0 = Jika 3 jawaban ya | 0,5  |
| <b>L Mengonsumsi dua porsi atau lebih buah atau sayuran setiap hari</b><br>0 = Tidak 1 = Ya                                                                                                                                                                                                                                           | 1    |
| <b>M Berapa banyak cairan (air, jus, kopi, teh, susu, dsb.) yang dikonsumsi setiap hari?</b><br>0,0 = Kurang dari 3 gelas<br>0,5 = 3 hingga 5 gelas<br>1,0 = Lebih dari 5 gelas                                                                                                                                                       | 0,5  |
| <b>N Cara makan</b><br>0 = Tidak bisa makan tanpa bantuan<br>1 = Makan sendiri meskipun sedikit sulit<br>2 = Makan sendiri tanpa masalah                                                                                                                                                                                              | 2    |
| <b>O Pendapat pribadi tentang status gizi</b><br>0 = Menganggap diri mengalami kurang gizi<br>1 = Tidak yakin dengan status gizi<br>2 = Menganggap diri tidak mengalami masalah gizi                                                                                                                                                  | 0    |
| <b>P Dibandingkan orang lain dengan usia yang sama, bagaimana pendapat pasien tentang status kesehatannya?</b><br>0,0 = Kurang baik<br>0,5 = Tidak tahu<br>1,0 = Sama baiknya<br>2,0 = Lebih baik                                                                                                                                     | 0,5  |
| <b>Q Lingkaran lengan atas (LLA) dalam cm</b><br>0,0 = LLA kurang dari 21<br>0,5 = LLA 21 hingga 22<br>1,0 = LLA lebih dari 22                                                                                                                                                                                                        | 0,5  |
| <b>R Lingkaran betis (LB) dalam cm</b><br>0 = LB kurang dari 31<br>1 = LB 31 atau lebih besar                                                                                                                                                                                                                                         | 0    |
| <b>Penilaian (maks. 16 poin)</b>                                                                                                                                                                                                                                                                                                      | 8,5  |
| <b>Skor skrining</b>                                                                                                                                                                                                                                                                                                                  | 7    |
| <b>Penilaian Total (MAKS. 30 poin)</b>                                                                                                                                                                                                                                                                                                | 15,5 |
| <b>Skor Indikator Malnutrisi</b><br>24-30 poin <input type="checkbox"/> = Status gizi normal<br>17-23,5 poin <input type="checkbox"/> = Berisiko mengalami malnutrisi<br>Kurang dari 17 poin <input checked="" type="checkbox"/> = Malnutrisi                                                                                         |      |

Figure 2. Completed Mini Nutritional Assessment instrument. Screening subtotal 7 of 14, assessment subtotal 8.5 of 16, total 15.5 of 30, corresponding to the malnourished category.

### Geriatric Screening: SKILAS

The simplified elderly screening instrument used within Indonesian primary care, SKILAS, operationalises the six intrinsic-capacity domains of the World Health Organization Integrated Care for Older People framework. The completed instrument is reproduced as Figures 3 and 4, and the results are tabulated in Table 6.

**Table 6. SKILAS intrinsic-capacity screening results**

| Domain        | Item and finding                                                                            | Result     | Alert |
|---------------|---------------------------------------------------------------------------------------------|------------|-------|
| Cognition     | Three-word recall and orientation to time and place; all questions answered correctly       | Normal     | No    |
| Locomotion    | Five repetitions of rising from a chair without using the arms, completed within 14 seconds | Normal     | No    |
| Nutrition     | Weight loss exceeding 3 kg in the preceding three months, or clothing becoming looser       | Yes        | Yes   |
| Nutrition     | Loss of appetite or difficulty eating                                                       | Yes        | Yes   |
| Nutrition     | Mid-upper arm circumference below 21 cm                                                     | No (23 cm) | No    |
| Vision        | Difficulty seeing at distance, reading, or known eye disease                                | No         | No    |
| Hearing       | Whispered voice test                                                                        | Passed     | No    |
| Psychological | Feeling down or depressed over the preceding two weeks                                      | No         | No    |
| Psychological | Little interest or pleasure in doing things                                                 | No         | No    |

The screening therefore identified an alert in a single domain, that of nutrition, with all five other intrinsic-capacity domains intact. This is a clinically informative pattern. Within large-scale implementations of the Integrated Care for Older People pathway, isolated vitality or nutrition alerts are common, and appetite loss and weight loss have been shown to associate strongly with impairment in the psychological and locomotion domains. The preservation of those domains in this patient suggests that the nutritional deficit is disease-driven and of relatively recent acceleration,

superimposed on chronic dietary inadequacy, rather than the terminal expression of generalised functional decline. This distinction carries a favourable prognostic implication and identifies nutrition as the single highest-yield target for intervention.<sup>26,38,39</sup>

#### Formulir Skrining Lansia Sederhana (SKILAS)

| Kondisi Prioritas Terkait Penurunan Kapasitas Intrinsik | Pertanyaan                                                                                                                                                                                                                   | Hasil                                                                                                                                                                                                                                                             |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Penurunan Kognitif                                      | 1. Mengingat tiga kata: bunga, pintu, nasi (sebagai contoh)<br>2. Orientasi terhadap waktu dan tempat:<br>a. Tanggal berapa sekarang?<br>b. Dimana Anda berada sekarang? (rumah, klinik, dsb.)<br>3. Ulangi ketiga kata tadi | <input type="checkbox"/> Salah pada salah satu pertanyaan<br><input type="checkbox"/> Tidak dapat mengulang ketiga kata<br><input checked="" type="checkbox"/> Semua pertanyaan dijawab tepat<br><input type="checkbox"/> Dapat mengulang kata yang harus diingat |
| <b>Tandai/Samakan Semua Jawaban</b>                     |                                                                                                                                                                                                                              | <input type="radio"/> Ya <input type="radio"/> Tidak                                                                                                                                                                                                              |
| Keterbatasan mobilisasi                                 | <b>Tes berdiri dari kursi:</b><br>Berdiri dari kursi lima kali tanpa menggunakan tangan. Apakah orang tersebut dapat berdiri di kursi sebanyak 5 kali dalam 14 detik ?                                                       | <input checked="" type="radio"/> Ya <input type="radio"/> Tidak                                                                                                                                                                                                   |
| Malnutrisi                                              | 1. Apakah berat badan Anda berkurang >3 kg dalam 3 bulan terakhir <b>atau pakaian menjadi lebih longgar ?</b>                                                                                                                | <input checked="" type="radio"/> Ya <input type="radio"/> Tidak                                                                                                                                                                                                   |
|                                                         | 2. Apakah Anda hilang nafsu makan Atau mengalami kesulitan makan (misal batuk atau tersedak saat makan, menggunakan selang makan/sonde) ?                                                                                    | <input checked="" type="radio"/> Ya <input type="radio"/> Tidak                                                                                                                                                                                                   |
|                                                         | 3. <b>Apakah ukuran lingkaran lengan atas (LiLA) &lt;21 cm?</b>                                                                                                                                                              | <input type="radio"/> Ya <input checked="" type="radio"/> Tidak                                                                                                                                                                                                   |

Figure 3. SKILAS screening instrument, cognition, locomotion and nutrition domains. The nutrition domain records positive responses for weight loss and for appetite loss, with mid-upper arm circumference above the 21 cm threshold.

|                      |                                                                                                                                                                |                                                                 |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Gangguan Penglihatan | Apakah Anda mengalami masalah pada mata: kesulitan melihat jauh, membaca, penyakit mata, atau sedang dalam pengobatan medis (diabetes, tekanan darah tinggi) ? | <input type="radio"/> Ya <input checked="" type="radio"/> Tidak |
| Gangguan Pendengaran | Mendengar bisikan saat <b>TES BISIK</b><br><small>Jika tidak dapat dilakukan Tes Bisik, rujuk Puskesmas</small>                                                | <input checked="" type="radio"/> Ya <input type="radio"/> Tidak |
| Gejala Depresi       | Selama 2 minggu terakhir, apakah Anda merasa terganggu oleh: Perasaan sedih, tertekan ?                                                                        | <input type="radio"/> Ya <input checked="" type="radio"/> Tidak |
|                      | Sedikit minat atau kesenangan dalam melakukan sesuatu                                                                                                          | <input type="radio"/> Ya <input checked="" type="radio"/> Tidak |

*Figure 4. SKILAS screening instrument, vision, hearing and depressive-symptom domains, all of which were negative in this patient.*

### Diagnostic Synthesis

The Global Leadership Initiative on Malnutrition criteria require at least one phenotypic and at least one aetiological criterion for a diagnosis of malnutrition to be established. The application of these criteria to the present patient is set out in Table 7.<sup>4</sup>

**Table 7. Application of the GLIM criteria for the diagnosis and grading of malnutrition**

| Criterion type | Criterion                           | Present | Evidence in this patient                                                                                           |
|----------------|-------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------|
| Phenotypic     | Non-volitional weight loss          | Yes     | Documented loss exceeding 3 kg over three months, corroborated by MNA item B and by SKILAS                         |
| Phenotypic     | Low body mass index                 | Yes     | 13.8 kg/m <sup>2</sup> , far below the threshold of 20 kg/m <sup>2</sup> applied to persons aged 70 years and over |
| Phenotypic     | Reduced muscle mass                 | Yes     | Mid-upper arm circumference 23 cm and calf circumference below 31 cm                                               |
| Aetiological   | Reduced food intake or assimilation | Yes     | Chronic energy-dilute diet with an acute one-week decline in appetite                                              |
| Aetiological   | Inflammation or disease burden      | Yes     | Bacteriologically confirmed active pulmonary tuberculosis                                                          |

|                  |                              |     |                                                                               |
|------------------|------------------------------|-----|-------------------------------------------------------------------------------|
| Severity grading | Stage 2, severe malnutrition | Yes | Body mass index below 18.5 kg/m <sup>2</sup> combined with severe weight loss |
|------------------|------------------------------|-----|-------------------------------------------------------------------------------|

All three phenotypic and both aetiological criteria are satisfied, and the severity grading is stage 2, severe malnutrition. The final problem list comprises: bacteriologically confirmed new pulmonary tuberculosis; severe protein-energy malnutrition, GLIM stage 2; disease-related malnutrition with inflammation, clinically consistent with cachexia; probable sarcopenia, not formally confirmed; anorexia with a chronic and an acute component; and current tobacco use.

The designation of probable rather than confirmed sarcopenia requires explanation. Confirmation under the revised European consensus requires demonstration of low muscle strength together with low muscle quantity or quality, neither of which was measured, and the patient completed the five-times chair-stand test within the 14-second threshold, which argues against low physical performance. Reduced mid-upper arm and calf circumference nonetheless indicate diminished muscle mass, so the condition is suspected but not established, and grip dynamometry is required to resolve it.<sup>6</sup>

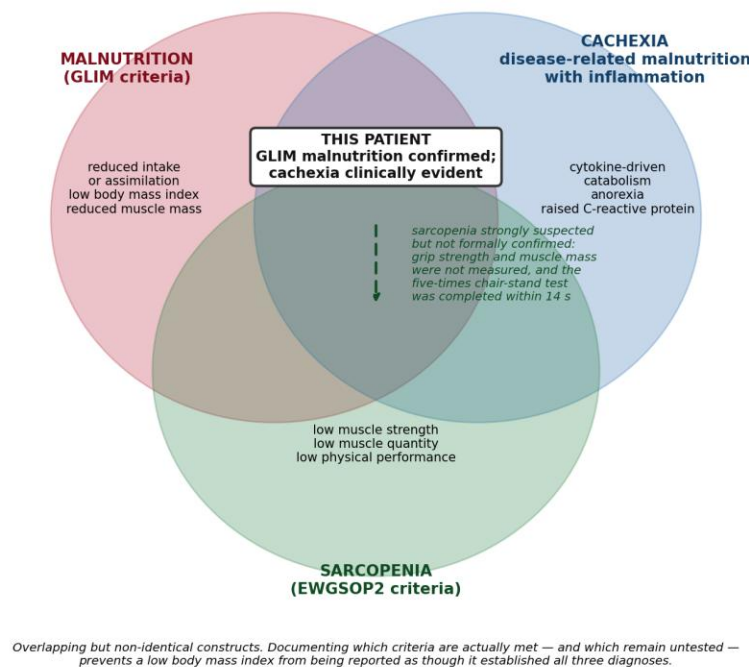


*Figure 5. Relationship between malnutrition, cachexia and sarcopenia as applied to this patient. Malnutrition is confirmed by GLIM criteria and cachexia is clinically evident, whereas sarcopenia remains suspected but unconfirmed because muscle strength and muscle quantity were not measured.*

## Management

### Antituberculosis and Symptomatic Therapy

The patient was commenced on a standard six-month regimen comprising a two-month intensive phase followed by a four-month continuation phase, with a recorded fixed-dose combination dose of four tablets once daily. Symptomatic therapy consisted of ambroxol 30 mg three times daily and cetirizine 10 mg once daily. The prescription as recorded is summarised in Table 8.

**Table 8. Pharmacological therapy as recorded at initiation**

| Agent | Dose and frequency | Duration | Indication |
|-------|--------------------|----------|------------|
|       |                    |          |            |

|                                                 |                         |                                                       |                                                                                        |
|-------------------------------------------------|-------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------|
| Fixed-dose combination antituberculosis therapy | 4 tablets once daily    | Intensive phase 2 months, continuation phase 4 months | Bacteriologically confirmed pulmonary tuberculosis                                     |
| Ambroxol                                        | 30 mg three times daily | Symptom-limited                                       | Mucolytic therapy for productive cough                                                 |
| Cetirizine                                      | 10 mg once daily        | Symptom-limited                                       | Rhinorrhoea                                                                            |
| Pyridoxine                                      | Not recorded            | —                                                     | Prophylaxis against isoniazid-induced peripheral neuropathy; indicated in this patient |

Two aspects of this prescription require attention. The first concerns the tablet number. Standard adult weight bands for the four-drug fixed-dose combination containing rifampicin 150 mg, isoniazid 75 mg, pyrazinamide 400 mg and ethambutol 275 mg allocate three tablets daily to the 38 to 54 kg band and four tablets daily to the 55 to 70 kg band. At 40 kg this patient falls within the three-tablet band. The resulting milligram-per-kilogram exposures under each option are compared in Table 9.

**Table 9. Milligram-per-kilogram exposure at 40 kg body weight under three-tablet and four-tablet regimens**

| Drug       | Target range (mg/kg) | 3 tablets: dose and mg/kg | 4 tablets: dose and mg/kg | Comment                                                        |
|------------|----------------------|---------------------------|---------------------------|----------------------------------------------------------------|
| Rifampicin | 8–12                 | 450 mg (11.3)             | 600 mg (15.0)             | Four tablets exceed the upper target; three tablets sit within |

|              |       |                |                | range                                                                            |
|--------------|-------|----------------|----------------|----------------------------------------------------------------------------------|
| Isoniazid    | 4–6   | 225 mg (5.6)   | 300 mg (7.5)   | Four tablets exceed the upper target, raising hepatotoxicity and neuropathy risk |
| Pyrazinamide | 20–30 | 1200 mg (30.0) | 1600 mg (40.0) | Four tablets substantially exceed the upper target                               |
| Ethambutol   | 15–20 | 825 mg (20.6)  | 1100 mg (27.5) | Four tablets markedly exceed the upper target, raising optic neuropathy risk     |

The four-tablet regimen therefore delivers doses above the accepted target range for all four agents. In a 73-year-old patient this is not a trivial matter, since older adults experience adverse antituberculosis drug reactions considerably more frequently than younger patients, and ethambutol-associated optic toxicity is both dose-related and difficult to detect early in a patient who may not volunteer visual symptoms. The recorded dose should be verified against the dispensed product and against the patient's weight band before the intensive phase proceeds, and weight should be re-measured monthly with dose re-banded as weight is regained.<sup>11,40</sup>

The second concerns pyridoxine, which was not recorded. Prophylactic pyridoxine is indicated for patients receiving isoniazid who are at elevated risk of peripheral neuropathy, a group that explicitly includes older adults and the undernourished. This patient belongs to both categories, and the omission should be corrected at the earliest opportunity.

## Nutritional Prescription

Nutritional requirements were derived from actual body weight of 40 kg rather than from ideal body weight, in accordance with refeeding safety principles. Because this patient meets criteria for the highest refeeding risk stratum, energy delivery was planned to begin at 10 kcal per kilogram daily and to escalate over approximately seven to ten days towards a repletion target. The phased prescription is presented in Table 10 and displayed graphically in Figure 6.<sup>23,41,42</sup>

**Table 10. Phased energy, protein and fluid prescription calculated for an actual body weight of 40 kg**

| Phase                      | Energy                                   | Protein                       | Fluid                                                   | Concurrent measures                                                                                                           |
|----------------------------|------------------------------------------|-------------------------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Days 1–3<br>(highest risk) | 10 kcal/kg =<br>400 kcal/day             | 0.8 g/kg = 32<br>g/day        | Approximately<br>30 mL/kg with<br>sodium<br>restriction | Thiamine 200–300 mg<br>daily commenced<br>before the first feed;<br>multivitamin and trace<br>elements; daily<br>electrolytes |
| Days 4–7                   | 15–25 kcal/kg<br>= 600–1000<br>kcal/day  | 1.0–1.2 g/kg =<br>40–48 g/day | Liberalise as<br>tolerated                              | Continue thiamine;<br>correct potassium,<br>phosphate and<br>magnesium as<br>required; daily<br>electrolytes                  |
| Days 8–14                  | 30–35 kcal/kg<br>= 1200–1400<br>kcal/day | 1.2–1.5 g/kg =<br>48–60 g/day | Approximately<br>2.0 L/day                              | Electrolytes on<br>alternate days;<br>commence resistance-<br>based activity as<br>tolerated                                  |

|                            |                                          |                        |                            |                                                                                         |
|----------------------------|------------------------------------------|------------------------|----------------------------|-----------------------------------------------------------------------------------------|
| From week 3<br>(repletion) | 35–40 kcal/kg<br>= 1400–1600<br>kcal/day | 1.5 g/kg = 60<br>g/day | Approximately<br>2.0 L/day | Oral nutritional<br>supplement if oral<br>intake remains below<br>target; weekly weight |
|----------------------------|------------------------------------------|------------------------|----------------------------|-----------------------------------------------------------------------------------------|

The protein target of 1.2 to 1.5 g per kilogram daily follows the recommendation of the European Society for Clinical Nutrition and Metabolism expert group for older persons who are malnourished or at risk of malnutrition owing to acute or chronic illness, which is substantially above the 0.8 g per kilogram figure applied to healthy younger adults. Protein should be distributed across meals rather than concentrated in a single serving, and should where possible be paired with physical activity, since protein provision and muscular loading act synergistically on muscle protein synthesis in older people.<sup>43,44</sup>

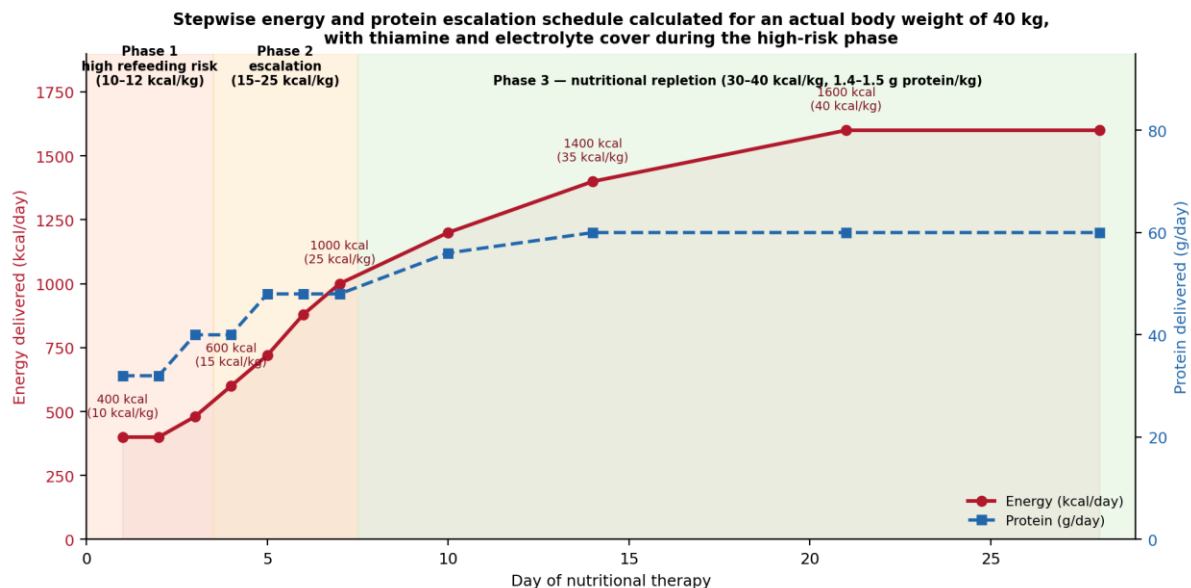


Figure 6. Stepwise energy and protein escalation schedule calculated for an actual body weight of 40 kg. Thiamine and electrolyte replacement accompany the high-risk phase; the repletion target is reached at approximately three weeks.

### Refeeding Risk Stratification and Monitoring

This patient satisfies more than one major criterion for very high refeeding risk, namely a body mass index below 16 kg/m<sup>2</sup> together with documented unintentional weight loss and reduced intake. The monitoring plan set out in Table 11 was therefore constructed around the recognised biochemical signature of the syndrome, which comprises hypophosphataemia, hypokalaemia and hypomagnesaemia developing after the reintroduction of nutrition, together with fluid retention and thiamine depletion.<sup>41,42</sup>

**Table 11. Monitoring plan during nutritional repletion and antituberculosis therapy**

| Parameter                             | Baseline                | During first 10 days                                         | Thereafter                         |
|---------------------------------------|-------------------------|--------------------------------------------------------------|------------------------------------|
| Serum phosphate, potassium, magnesium | Before first feed       | Daily, particularly days 2 to 4 when nadir most often occurs | Twice weekly until stable          |
| Body weight                           | At diagnosis            | Twice weekly                                                 | Monthly, with drug dose re-banded  |
| Mid-upper arm circumference           | At diagnosis            | —                                                            | Monthly                            |
| Fluid balance and peripheral oedema   | At diagnosis            | Daily clinical assessment                                    | At each visit                      |
| Haemoglobin                           | Recommended at baseline | —                                                            | At end of intensive phase          |
| Liver function tests                  | Recommended at baseline | If symptoms arise                                            | Monthly during intensive phase     |
| Visual acuity and colour vision       | Before ethambutol       | —                                                            | Monthly while ethambutol continues |
| Sputum bacteriology                   | At diagnosis            | —                                                            | End of month 2,                    |

|                             |              |                 |                       |
|-----------------------------|--------------|-----------------|-----------------------|
|                             |              |                 | month 5 and month 6   |
| Appetite and dietary intake | At diagnosis | At each contact | At each monthly visit |

It should be noted that hypophosphataemia has been documented in up to a quarter of older hospitalised patients undergoing refeeding, and that it occurs even when cautious rates of energy delivery are used, with the nadir most often falling between the second and fourth days. Cautious initiation therefore does not remove the need for biochemical surveillance; the two are complementary rather than alternative strategies.<sup>45,46</sup>

### **Adjunctive Measures**

Tobacco cessation counselling was indicated, given the established association between continued smoking and both poorer treatment outcome and increased risk of recurrence and death. Household contact investigation was indicated notwithstanding the absence of reported symptoms among family members. Nutritional counselling directed at increasing protein density within the existing dietary pattern, principally by increasing the frequency and portion size of the fish already consumed and by adding legumes and eggs, was preferred to wholesale dietary substitution, which is unlikely to be sustained.<sup>47,48</sup>

### **Outcome and Planned Follow-Up**

The patient was established on antituberculosis therapy with the phased nutritional prescription described above. Longitudinal outcome data beyond the initiation of therapy were not available at the time of writing, which constitutes an acknowledged limitation of this report. The planned follow-up schedule is anchored on the end of the intensive phase, at which point failure to achieve a five per cent gain from baseline weight, corresponding to approximately 2 kg in this patient, would prompt structured investigation for food insecurity, non-adherence, malabsorption, undiagnosed diabetes or drug resistance, in accordance with contemporary recommendations.<sup>8,9</sup>

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## DISCUSSION

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### Overview

This patient presents a convergence of processes that are ordinarily discussed separately. He is an older adult, in whom immune competence and nutritional reserve have both declined with age. He has active pulmonary tuberculosis, a disease that is simultaneously a consequence of and a cause of nutritional depletion. He has severe protein-energy malnutrition at a degree rarely encountered outside famine or advanced malignancy. And he carries a habitual dietary pattern and a smoking history that predate and contributed to both. The discussion that follows examines each element in turn and then addresses their integration into a single therapeutic plan, before considering the pharmacological and programmatic implications.

### Tuberculosis in the Older Adult

The epidemiology of tuberculosis in older adults has diverged from that of the general population. Age-stratified analysis of global burden data demonstrates that between 2015 and 2020 the reduction in tuberculosis mortality was approximately thirty-five per cent in children under five years but close to negligible in those aged seventy years and over, and that incidence declined more slowly in older age bands than in younger ones. The Western Pacific Region, which includes Indonesia, has one of the fastest-growing older populations globally while continuing to carry a substantial tuberculosis burden, so that the absolute number of elderly patients is rising even where age-specific rates are falling.<sup>3,10</sup>

Most tuberculosis in older adults arises from reactivation of infection acquired decades earlier, and the trigger for reactivation is the age-related waning of the immune containment that had previously held the organism in check. Consistent with this mechanism, cohorts of elderly patients demonstrate an over-representation of miliary disease relative to younger adults, a pattern interpreted as reflecting failure of granulomatous containment. Clinical series have repeatedly documented that older patients present with fewer and less pronounced symptoms, that radiological features are more often atypical, and that the interval from first presentation to initiation of therapy is longer.<sup>11,34,49</sup>

The present patient exemplifies this pattern precisely. He denied both fever and night sweats, the two symptoms most likely to prompt a clinician to consider tuberculosis, and presented after a month of cough. Surveillance data from southern China covering thirteen years demonstrate that the median total diagnostic delay among patients aged sixty and above remained stable at approximately thirty-two days despite improvements in patient delay, with a delay rate exceeding seventy-five per cent, and identify farming occupation and respiratory comorbidity as significant risk factors for prolonged delay. This patient was a farmer presenting with respiratory symptoms, and therefore sat within the demographic at highest risk of exactly this form of diagnostic delay.<sup>50,51</sup>

The clinical consequence of delay in this age group is not merely academic. Elderly patients experience significantly higher rates of unfavourable treatment outcome and of death than non-elderly patients, and in the very old, tuberculosis-attributable mortality rises steeply. Importantly, one study of very old patients found that when the diagnosis was made early and treatment was adequate, mortality did not exceed that of age-matched controls without tuberculosis, which locates the excess risk in delay and inadequate management rather than in age itself.<sup>30,40</sup>

### **Why Ageing Predisposes to Both Tuberculosis and Undernutrition**

Two ageing phenomena operate concurrently and reinforce one another. Immunosenescence describes the progressive structural and functional deterioration of both innate and adaptive immunity, encompassing thymic involution, contraction of the naive T-cell repertoire, accumulation of terminally differentiated lymphocytes and impaired responses to novel antigenic challenge. Inflammaging describes the chronic, sterile, low-grade systemic inflammation that accompanies advancing age in the absence of overt stimulus. The two are not independent: the failure to clear senescent cells, itself a consequence of immune decline, sustains the inflammatory secretory phenotype that drives inflammaging.<sup>20,52</sup>

Direct evidence links these processes to tuberculosis susceptibility. Older patients with pulmonary tuberculosis demonstrate an expansion of peripheral regulatory T cells with a reciprocal reduction in interferon-gamma-producing effector T cells, and the magnitude of regulatory T-cell enrichment correlates with bacillary load, declining as treatment succeeds. In experimental models, aged animals exhibit an expanded alveolar macrophage subpopulation with a distinct inflammatory

signature that phagocytoses greater numbers of mycobacteria yet permits enhanced intracellular survival. The ageing lung thus provides both an impaired effector response and a more permissive intracellular niche.<sup>53,54</sup>

The nutritional counterpart of this decline is equally consequential. The anorexia of ageing is a distinct geriatric syndrome, not simply a manifestation of disease, and is characterised by reduced hunger, earlier satiation and diminished compensatory hyperphagia after periods of underfeeding. Its mechanisms include delayed fundic relaxation and gastric emptying, augmented anorexigenic gut hormone responses to feeding, attenuated central opioid and neuropeptide Y signalling, and impairment of taste and smell. Systematic review evidence demonstrates that anorexia or appetite loss in older populations is consistently associated with increased risk of malnutrition and, in seventeen of eighteen longitudinal studies examined, with increased mortality, across community, institutional and hospital settings.<sup>21,22,36</sup>

The clinically important implication is that the loss of compensatory hyperphagia means an older adult who becomes anorexic during an acute illness will not spontaneously return to baseline weight once the illness resolves, in contrast to a younger patient. Recovery in this age group requires deliberate, prescribed nutritional intervention. The relationship between the ageing host, undernutrition and tuberculosis is represented schematically in Figure 7.

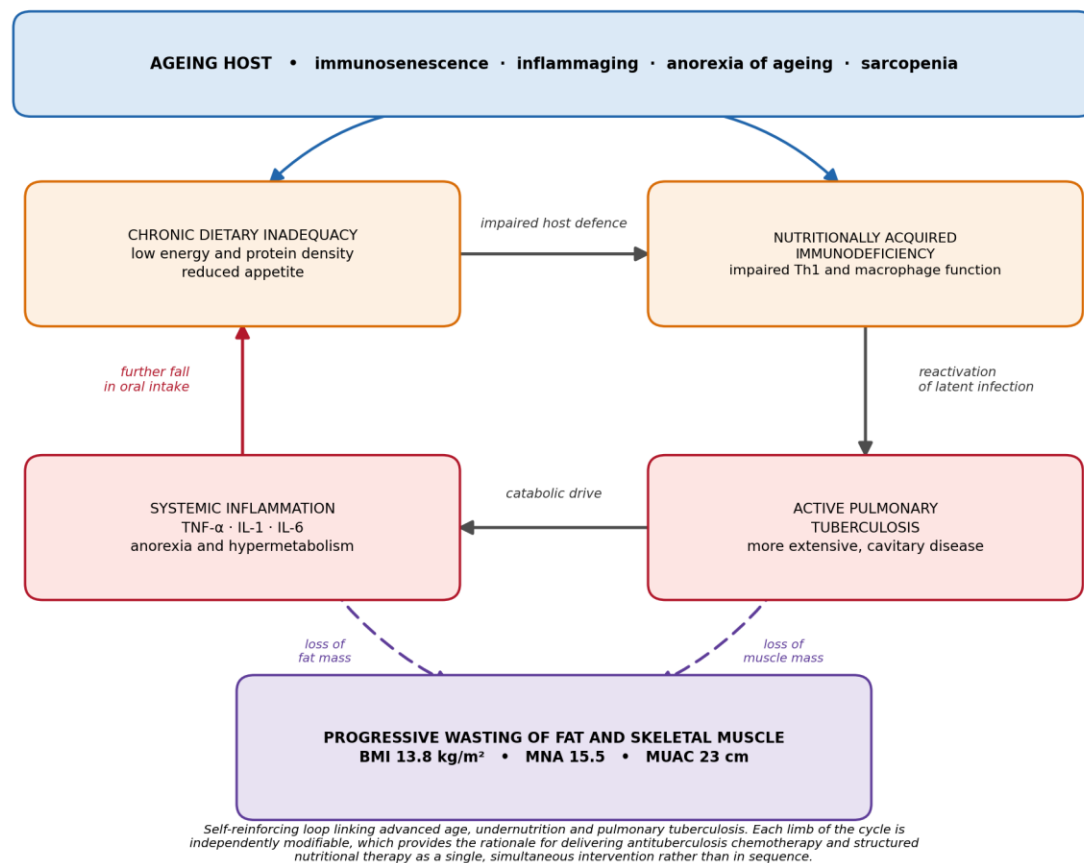


Figure 7. Self-reinforcing loop linking advanced age, undernutrition and pulmonary tuberculosis. Each limb of the cycle is independently modifiable, which provides the rationale for delivering chemotherapy and nutritional therapy simultaneously.

### The Bidirectional Relationship between Undernutrition and Tuberculosis

Undernutrition is now recognised as the leading population-level risk factor for tuberculosis worldwide. Its effect is mediated through what has been termed nutritionally acquired immunodeficiency: protein-energy deficiency and specific micronutrient deficiencies impair the innate and adaptive responses required to contain *Mycobacterium tuberculosis*, degrade granuloma formation and maintenance, and may attenuate responses to live vaccines including bacille Calmette-Guerin. Recent modelling has suggested that eliminating adult undernutrition could avert

close to a quarter of adult tuberculosis incidence globally, an estimate roughly two and a half times higher than the population attributable fraction conventionally cited.<sup>1,2,12</sup>

The temporal dimension of this relationship has been quantified. A Korean national cohort of more than two million individuals demonstrated that the accumulated number of years spent underweight predicted subsequent tuberculosis in a graded fashion, with the highest accumulated burden of underweight associated with a more than threefold adjusted hazard after adjustment for demographic factors and comorbidity. Undernutrition is therefore not merely a marker of concurrent illness but an antecedent exposure with cumulative effect, which is consistent with the chronic dietary pattern described by the present patient.<sup>55</sup>

The reverse direction is equally well documented. Active tuberculosis reduces appetite, impairs nutrient absorption, alters intermediary metabolism and increases resting energy expenditure, producing wasting even where intake is nominally maintained. The resulting phenotype is one in which loss of lean tissue is disproportionate to loss of fat, a pattern demonstrated in body composition studies of adults with pulmonary tuberculosis in which mid-upper arm circumference and arm muscle circumference were reduced independently of body mass index, and in which indicators of low lean body mass tracked with disease severity and socioeconomic disadvantage.<sup>13,56</sup>

Household food insecurity has been identified as an independent determinant of underweight among people with tuberculosis, which situates the nutritional deficit within a social as well as a biological frame and indicates that counselling alone will be insufficient where the underlying constraint is access to food.<sup>57</sup>

### **Severity of Undernutrition and Its Prognostic Weight**

A body mass index of 13.8 kg/m<sup>2</sup> lies far below the 16.0 kg/m<sup>2</sup> threshold conventionally used to define severe undernutrition, and below the 14 kg/m<sup>2</sup> level that identified the most severely affected stratum within the RATIONS patient cohort, in which approximately one in six participants fell below that value. In the rural central Indian cohort of nearly seventeen hundred adults with pulmonary tuberculosis, median body mass index at diagnosis was 16.0 kg/m<sup>2</sup> in men, and severe undernutrition at diagnosis was associated with a roughly twofold higher risk of death during

treatment. The present patient therefore sits at the extreme end of a distribution that is itself associated with substantially elevated mortality.<sup>8,19</sup>

Nutritional status at diagnosis also determines the character of the disease itself. Among patients with smear-positive, culture-confirmed pulmonary tuberculosis, those with severe malnutrition had on average eleven per cent more lung parenchyma affected and a more than fourfold increased odds of cavitation compared with those of normal body mass index, after adjustment for diabetes and smoking. Undernutrition is therefore associated not only with worse outcomes but with more extensive disease at the point of presentation, an observation that reinforces the importance of chest radiography in this patient, which was not documented.<sup>17</sup>

Undernutrition additionally predicts unsuccessful treatment outcome, defined as a composite of death, treatment failure and loss to follow-up, with an approximately twofold adjusted hazard in a multicentre Ethiopian cohort. Pooled estimates from the same country place the prevalence of undernutrition among patients with tuberculosis at close to half, with low income, inability to work and eating disorders among the significant determinants.<sup>16,18</sup>

Finally, the consequences extend beyond the treatment episode. Pretreatment undernutrition has been associated with significantly impaired lung function at the point of microbiological cure, with undernourished patients demonstrating approximately nine per cent lower percentage-predicted forced expiratory volume in one second after adjustment for sex, age, human immunodeficiency virus status and smoking. Older age is itself an identified risk factor for post-tuberculosis pulmonary sequelae. This patient therefore carries risk not only for adverse outcome during treatment but for persistent respiratory disability thereafter.<sup>58,59</sup>

### **Discordance between Anthropometric Indices**

An instructive feature of this case is the discordance between body mass index and mid-upper arm circumference. The body mass index of 13.8 kg/m<sup>2</sup> indicates undernutrition of extreme severity, whereas the mid-upper arm circumference of 23 cm, although reduced, is less alarming and indeed scored a full point on the corresponding Mini Nutritional Assessment item and generated no alert on SKILAS, which uses a threshold of 21 cm.

Reference data clarify the magnitude of this discordance. In a West African cohort of more than two thousand patients with tuberculosis, the mid-upper arm circumference cut-offs corresponding to body mass index values of 20, 18.5, 17 and 16 kg/m<sup>2</sup> were 25, 24, 23 and 22.5 cm respectively, and mortality risk increased significantly below 22 cm. A mid-upper arm circumference of 23 cm therefore corresponds approximately to a body mass index of 17 kg/m<sup>2</sup>, some three units above the value actually measured. An individual participant data meta-analysis across twenty datasets similarly identified cut-offs in the range of 23.5 to 25.0 cm as appropriate for identifying a body mass index below 18.5 kg/m<sup>2</sup> in adults.<sup>29,60</sup>

Two clinical lessons follow. The first is that mid-upper arm circumference, although an excellent screening tool with an area under the receiver operating characteristic curve approaching 0.9 and of proven value in predicting death among acutely unwell patients on tuberculosis wards, is a screening rather than a staging instrument, and in this patient would have underestimated severity if used alone. The second is that the 21 cm threshold embedded in the SKILAS instrument, while appropriate for the purpose of identifying older people requiring further assessment within a general population, is considerably more conservative than tuberculosis-specific thresholds and would not have flagged this patient on that item.<sup>61</sup>

This is precisely the failure mode that the systematic review of malnutrition assessment methods in tuberculosis identified, in which more than three-quarters of published studies relied on body mass index alone and fewer than one in twenty captured all three domains of the conceptual definition of malnutrition. Reliance on any single index, whichever is chosen, risks misclassification; concurrent measurement is what generated the accurate picture in this patient.<sup>28</sup>

### **Performance and Selection of Nutritional Screening Instruments**

The Mini Nutritional Assessment was developed specifically for geriatric use and has been applied across community, hospital, rehabilitation and nursing home settings. Pooled multinational data using the full instrument reported a malnutrition prevalence of 22.8 per cent overall with a further 46.2 per cent at risk, and demonstrated marked variation by setting, ranging from 5.8 per cent in the community to 50.5 per cent in rehabilitation. The short form was derived to retain diagnostic accuracy while shortening administration, and against clinical nutritional status as

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reference standard achieved a sensitivity of 97.9 per cent and specificity of 100 per cent in the derivation dataset.<sup>5,25</sup>

Meta-analytic evidence in community-dwelling older adults supports the short form, with pooled sensitivity and specificity both approximating 0.95 against the long form as reference. The instrument also carries information beyond nutrition alone: against the Fried phenotype, the Mini Nutritional Assessment achieved an area under the curve of 0.903 for the detection of frailty, indicating that it captures a construct broader than nutritional status in isolation.<sup>62,63</sup>

Its performance in the specific population represented by this patient has also been examined. In a cross-sectional study of 532 older adults with pulmonary tuberculosis at a tertiary infectious diseases hospital, 79.5 per cent had an abnormal Mini Nutritional Assessment score, and nutritional score correlated positively with Berg Balance Scale performance and inversely with timed up-and-go and five-times sit-to-stand times. Nutritional status in this population is therefore not merely a body composition variable but is coupled to physical function.<sup>31</sup>

This last finding provides a useful frame for interpreting the apparent paradox in the present patient, who completed the five-times chair-stand test within fourteen seconds despite a body mass index of 13.8 kg/m<sup>2</sup>. The most plausible interpretation is that functional decline lags behind compartmental depletion, so that this patient has been identified within a window in which physical performance remains salvageable. That window is the argument for immediate rather than deferred nutritional intervention.

### **Malnutrition, Cachexia and Sarcopenia: Overlapping but Distinct Constructs**

Precision in terminology matters here because the three constructs imply different therapeutic expectations. Malnutrition under the Global Leadership Initiative on Malnutrition framework requires one phenotypic and one aetiological criterion, and is graded into moderate and severe stages; it is, in principle, correctable by provision of nutrients where the aetiological driver is intake or assimilation.<sup>4</sup>

Cachexia was defined by consensus as a complex metabolic syndrome associated with underlying illness and characterised by loss of muscle with or without loss of fat mass, in which anorexia, inflammation, insulin resistance and increased muscle protein breakdown are frequently

present, and which is explicitly distinguished from simple starvation. The international consensus on cancer cachexia set the diagnostic threshold at weight loss exceeding five per cent, or exceeding two per cent in individuals already depleted with a body mass index below 20 kg/m<sup>2</sup>. The European Society for Clinical Nutrition and Metabolism subsequently treated cachexia as synonymous with disease-related malnutrition with inflammation, and has emphasised the role of inflammatory phenotyping in guiding the intensity and expectations of nutritional therapy.<sup>7,64-66</sup>

The immunological basis of infection-associated cachexia has been increasingly well characterised, with cytokine-driven and immune-cell-driven pathways depleting both fat and muscle and carrying prognostic consequence independent of the underlying pathogen. This patient meets the weight-loss criterion for cachexia and demonstrates anorexia in the presence of an active inflammatory infectious illness; however, no inflammatory biomarker was measured, so the designation rests on clinical rather than biochemical grounds and is reported here as clinically evident rather than biochemically confirmed.<sup>27</sup>

Sarcopenia is defined by the revised European consensus as a muscle disease in which low muscle strength is the principal characteristic, confirmed by low muscle quantity or quality, with poor physical performance indicating severe disease. Prevalence among patients with tuberculosis is substantial: in a Malaysian cross-sectional study applying Asian Working Group criteria, 33.9 per cent of patients with tuberculosis met criteria for sarcopenia, with lower daily protein intake and body mass index among the independent risk factors. In the present patient, however, neither grip strength nor muscle quantity was measured and physical performance was preserved, so sarcopenia is appropriately designated probable rather than confirmed. Reporting it otherwise would represent an inference from body mass index rather than a diagnosis.<sup>6,67</sup>

The practical importance of the distinction is that malnutrition arising predominantly from inadequate intake responds well to nutritional provision alone, whereas cachexia with a strong inflammatory component responds only partially to nutrients and requires control of the underlying disease, and sarcopenia requires the combination of protein provision with mechanical loading. This patient requires all three approaches simultaneously: effective antituberculosis chemotherapy to

interrupt the inflammatory drive, structured energy and protein provision to correct the deficit, and progressive physical activity to convert the provided substrate into functional muscle.

### **Derivation of Energy and Protein Requirements**

The European Society for Clinical Nutrition and Metabolism recommends approximately 30 kcal per kilogram of body weight daily as a general orientation for older persons, with the value individualised according to nutritional status, physical activity level, disease state and tolerance. For malnourished older adults the ultimate target must exceed maintenance requirements, since repletion of depleted compartments requires positive energy balance, and figures in the range of 35 to 40 kcal per kilogram are appropriate during the repletion phase.<sup>23,44</sup>

Protein requirements in older persons are higher than in younger adults because of anabolic resistance, in which a given quantity of amino acid produces a smaller muscle protein synthetic response. The expert group recommendation is at least 1.0 to 1.2 g per kilogram daily for healthy older people and 1.2 to 1.5 g per kilogram daily for those who are malnourished or at risk of malnutrition because of acute or chronic illness, with higher values considered in severe illness or injury. For this patient at 40 kg, the resulting target of 48 to 60 g of protein daily was derived directly from that recommendation.<sup>43</sup>

A deliberate decision was taken to calculate requirements from actual rather than ideal body weight during the initial phases. Calculating from an ideal body weight of 63 kg would have generated an initial energy prescription more than fifty per cent higher than that derived from actual weight, which in a patient at very high refeeding risk would be unsafe. Requirements were therefore anchored to actual weight and recalculated as weight is regained, which also aligns with the requirement to re-band antituberculosis drug dosing.

For orientation against a benchmark of known efficacy, the RATIONS patient cohort received food rations delivering 1200 kcal and 52 g of protein daily as a supplement to habitual intake, over six months for drug-susceptible disease with extension for those whose body mass index remained below 18.5 kg/m<sup>2</sup> at the end of treatment. The repletion target derived for this patient is of a comparable order, and the extension criterion is directly applicable to him.<sup>8</sup>

### **Refeeding Syndrome**

Refeeding syndrome comprises the fluid and electrolyte shifts that follow the reintroduction of nutrition to a malnourished patient. During starvation, insulin secretion falls and catabolic pathways predominate; the reintroduction of carbohydrate provokes insulin release, which drives glucose, potassium, phosphate and magnesium intracellularly and stimulates the sodium-potassium pump, producing hypophosphataemia, hypokalaemia and hypomagnesaemia together with sodium and water retention. Thiamine, a cofactor for carbohydrate metabolism, is rapidly consumed and may become critically depleted. The resulting derangements can affect cardiac, respiratory, haematological, hepatic and neuromuscular function and may be fatal.<sup>41,42</sup>

This patient falls within the highest risk stratum by any recognised criteria, given a body mass index far below 16 kg/m<sup>2</sup> combined with documented unintentional weight loss and reduced intake. Two features of the geriatric evidence base warrant emphasis. First, a systematic review restricted to patients aged sixty-five and above found that hypophosphataemia occurred in up to a quarter of older hospitalised adults undergoing refeeding, and that a rapid fall in phosphate occurred at both 8 to 10 and 30 kcal per kilogram daily, with the nadir most frequently between days two and four. Cautious initiation therefore mitigates but does not abolish risk. Second, a prospective study of malnourished older inpatients managed according to consensus recommendations nonetheless documented imminent or manifest refeeding syndrome in nineteen per cent, although without excess mortality, which the authors attributed to early recognition and treatment.<sup>45,46</sup>

The corollary for the present case, managed in a primary care setting where daily biochemistry may not be available, is that the risk cannot be managed by cautious feeding alone. Where electrolyte monitoring cannot be assured locally, the safest course is either to arrange monitoring through a referral facility during the first week or to consider short-term admission for initiation. Thiamine supplementation at 200 to 300 mg daily commenced before the first feed, together with multivitamin and trace element provision, is inexpensive, carries negligible risk and should be regarded as mandatory rather than optional in a patient of this severity.

### **Nutritional Status and Antituberculosis Drug Exposure**

Body weight is a consistent determinant of first-line antituberculosis drug exposure. In a prospective Chinese pharmacological cohort, patients weighing less than 38 kg were exposed to

30.4, 45.9 and 18.0 per cent lower areas under the concentration-time curve for rifampicin, isoniazid and pyrazinamide respectively than those weighing 70 kg or more, and simulations demonstrated significantly lower exposures across all three agents in the lower weight bands. Analysis of first-line drug plasma concentrations in a separate cohort identified serum albumin as positively correlated with rifampicin concentration and age as a determinant of ethambutol concentration.<sup>32,33</sup>

Body weight has also been identified as the principal covariate on rifampicin clearance and volume of distribution, with participants weighing less than 50 kg failing to achieve the plasma exposure attained by heavier patients, and low systemic exposure attributed substantially to formulation bioavailability. Suboptimal exposure is of concern because it is associated with unfavourable outcomes and with the selection of resistance.<sup>1,68</sup>

These observations create a genuine therapeutic tension in the present patient, and it is worth stating the tension explicitly rather than resolving it too neatly. On one hand, very low body weight is associated with reduced drug exposure, which argues against reflexive dose reduction. On the other, the recorded four-tablet regimen delivers milligram-per-kilogram doses above the accepted target range for all four agents at 40 kg, as set out in Table 9, and older adults are considerably more susceptible to adverse antituberculosis drug reactions, with ethambutol optic neuropathy and drug-induced liver injury of particular concern.<sup>11,40</sup>

The appropriate resolution is not to select intuitively between these considerations but to follow the weight band, which represents the calibrated compromise between them, while monitoring actively. That means confirming the dispensed formulation and tablet number against the 38 to 54 kg band, re-measuring weight monthly and re-banding the dose upward as weight is regained, adding pyridoxine prophylaxis, arranging baseline and monthly transaminases during the intensive phase, and performing baseline and monthly visual acuity and colour vision assessment while ethambutol continues. Where facilities permit, therapeutic drug monitoring would be the definitive means of resolving the tension, and its role has been advocated precisely in undernourished populations.<sup>1,69</sup>

### **Micronutrients and Adjunctive Nutritional Agents**

Micronutrient deficiencies are common in tuberculosis, and antituberculosis drugs themselves interact with nutrient status, most notably through the effect of isoniazid on pyridoxine metabolism. A narrative review of nutritional deficiencies in tuberculosis emphasises that polytherapy modifies multiple metabolic pathways and that nutritional support should be evaluated on an individual basis by a team encompassing the prescribing physician, pharmacist and nutritionist.<sup>69</sup>

The evidence for specific supplementation is, however, more modest than is often assumed, and this distinction matters for setting expectations. An Indonesian randomised placebo-controlled trial of vitamin A and zinc supplementation demonstrated earlier sputum conversion and earlier resolution of radiographic lesion area, with higher plasma retinol concentrations at six months. A subsequent meta-analysis of nine randomised trials found that combined zinc and vitamin A supplementation significantly increased two-month sputum smear conversion and raised serum zinc, retinol and haemoglobin concentrations, but that neither zinc, nor vitamin A, nor the combination was significantly associated with treatment success. A Cochrane review found limited evidence that high-energy supplements and certain zinc-containing combinations assisted weight gain, with no demonstrated effect on death or on end-of-treatment sputum results.<sup>70-72</sup>

Adjunctive vitamin D has been examined extensively. An individual participant data meta-analysis of eight trials involving 1850 participants found no influence on time to sputum culture conversion overall, although sputum smear conversion was modestly accelerated and a significant effect was observed in the subgroup with multidrug-resistant disease.<sup>73</sup>

The reasonable conclusion is that micronutrient repletion should be provided as part of a complete nutritional strategy, particularly where a monotonous diet makes deficiency probable, and that thiamine and pyridoxine have specific and non-negotiable indications in this patient. Isolated micronutrient supplementation should not, however, be presented to the patient or the programme as a substitute for adequate energy and protein delivery, which remains the intervention with the strongest outcome evidence.

### **Evidence that Nutritional Support Alters Tuberculosis Outcomes**

The RATIONS trial provides the strongest available evidence. In this field-based, open-label, cluster-randomised controlled trial conducted across twenty-eight tuberculosis units in Jharkhand, India, household contacts of patients with microbiologically confirmed pulmonary tuberculosis in the intervention group received monthly food rations delivering 750 kcal and 23 g of protein daily with micronutrients, while patients in both groups received rations delivering 1200 kcal and 52 g of protein daily. Among 10,345 household contacts followed over 21,869 person-years, tuberculosis incidence fell by thirty-nine per cent for all forms and by forty-eight per cent for microbiologically confirmed pulmonary disease, with an estimated thirty households requiring supplementation to prevent one incident case.<sup>24</sup>

The nested patient cohort addressed outcomes among those already ill. Among 2800 patients, of whom 82.4 per cent were underweight at enrolment, treatment succeeded in 93.7 per cent, median weight gain was 4.6 kg, and a five per cent weight gain by two months was associated with a reduced hazard of death, with an adjusted hazard ratio of 0.39. Notably, 54.8 per cent remained underweight at the end of treatment despite supplementation, which indicates both that the deficit in such populations is profound and that six months of support may be insufficient.<sup>8</sup>

The operational translation of these findings recommends standard nutritional assessment with anthropometry and haemoglobin at treatment initiation, macronutrient and micronutrient support with counselling, weight monitoring throughout, structured investigation where weight gain fails to occur by the end of the intensive phase, reassessment of anthropometry at treatment completion, and close follow-up of those who remain underweight because of their elevated relapse risk.<sup>9</sup>

Longitudinal data indicate that most weight recovery occurs early. In a Korean cohort followed for two years, body mass index increased significantly during treatment in the smear-positive group, with almost all of the change occurring in the early phase and little further change thereafter. This reinforces the emphasis on the first two months as the critical window and validates the use of two-month weight gain as an accessible surrogate marker in settings without laboratory capacity.<sup>74</sup>

### **Smoking as a Shared Risk Factor**

This patient smoked ten cigarettes daily, which is relevant on three separate grounds. First, smoking approximately doubles the risk of tuberculosis disease and of tuberculosis death, with consistent evidence of association across infection, disease and mortality endpoints. Second, smoking worsens treatment outcomes: meta-analysis demonstrates a fifty-one per cent increase in the odds of poor treatment outcome among smokers, with ever and current tobacco use associated with markedly increased risks of recurrence or relapse and of mortality during treatment. Third, cigarette smoke exposure impairs the specific immune mechanisms already compromised by ageing and undernutrition, including innate barrier defences, alveolar macrophage function and dendritic and T-cell responses.<sup>47,48,75,76</sup>

The combination of risk factors in this patient is of more than additive concern. Individual participant data meta-analyses across fourteen high-burden countries demonstrated that joint exposures produce risks substantially greater than either alone, with relative risks of the order of three to six for combinations involving low body mass index. Tobacco cessation should therefore be presented to the patient not as generic health advice but as a component of tuberculosis treatment with a defined effect on the probability of cure.<sup>77</sup>

### **Diagnostic Considerations**

The diagnosis in this patient rested on a single sputum nucleic acid amplification test. The most recent Cochrane review of Xpert MTB/RIF Ultra in adults and adolescents, incorporating thirty-two studies and 12,529 participants, reported a summary sensitivity of 90.7 per cent and specificity of 94.8 per cent against culture, with high-certainty evidence. Sensitivity is lower in smear-negative culture-positive disease at 80.7 per cent, and specificity falls to 86.2 per cent in those with a history of previous tuberculosis. The earlier multicentre accuracy study that established the assay reported that the gain in sensitivity relative to the preceding generation came at the cost of a modest reduction in specificity.<sup>78-80</sup>

Two implications follow for this patient. Since he had no history of previous tuberculosis, the specificity concern associated with prior disease does not apply, and a positive result in a symptomatic patient with this pretest probability is reliable. However, the rifampicin susceptibility component of the result was not documented in the available record, and this must be retrieved,

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since it determines whether the standard regimen is appropriate at all. The absence of documented chest radiography is a second gap, given that undernutrition is associated with greater disease extent and cavitation, both of which influence prognosis and infectiousness.<sup>17</sup>

### **Integrating Nutritional and Geriatric Assessment in Primary Care**

This case demonstrates that comprehensive nutritional and geriatric characterisation is achievable at community health centre level using instruments already deployed within the Indonesian primary care system. The Integrated Care for Older People pathway, of which SKILAS is the local operationalisation, has been implemented at scale, with more than ten thousand participants screened in a French regional programme and follow-up rates exceeding seventy per cent, demonstrating feasibility in routine practice. Validation work indicates that the screening tool provides high specificity across most intrinsic-capacity domains, with the vitality domain closely linked to nutritional status.<sup>26,38,81</sup>

Impairment in intrinsic capacity is prognostically meaningful. In population-based cohorts across Latin America, India and China, one or more declines in intrinsic capacity independently predicted incident dependence and death, and most care needs arose among those with declines who had not yet become frail. Screening therefore identifies a group in whom intervention remains capable of altering trajectory, which is precisely the position of the present patient, whose only abnormal domain was nutrition and whose locomotor, cognitive and psychological domains were intact.<sup>39</sup>

The two instruments used in this case are complementary rather than duplicative. SKILAS identified that the abnormality was confined to the nutrition domain, providing reassurance about functional reserve and locating the therapeutic target. The Mini Nutritional Assessment then quantified the severity of that abnormality and, together with anthropometry, generated the numbers from which a prescription could be calculated. Neither would have been sufficient alone: SKILAS would not have quantified severity, and the Mini Nutritional Assessment would not have established that the other five domains were intact.

The principal barrier to wider implementation is not instrument availability but the absence of a defined pathway linking a positive screen to a calculated prescription. The recommendation

that nutritional metrics be reported annually and that nutritional assessment be explicitly included within national strategic plans addresses this gap at the programmatic level.<sup>9</sup>

### **Practical Framework Emerging from This Case**

Drawing the preceding threads together, a practical sequence can be proposed for the older patient with tuberculosis and undernutrition in primary care, summarised in Table 12.

**Table 12. Proposed practical sequence for the older adult with tuberculosis and undernutrition in primary care**

| Step | Action                                                                                                                       | Rationale and reference standard                                                                             |
|------|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| 1    | Measure weight, height and mid-upper arm circumference in every patient at tuberculosis diagnosis; calculate body mass index | Reliance on a single index misclassifies severity; concurrent measurement is required                        |
| 2    | Administer a validated geriatric nutritional instrument in patients aged 60 and over                                         | The Mini Nutritional Assessment is validated in this population and additionally screens for frailty         |
| 3    | Screen all six intrinsic-capacity domains                                                                                    | Identifies whether the deficit is isolated or part of generalised decline, which alters prognosis and target |
| 4    | Apply the GLIM criteria and grade severity                                                                                   | Provides an internationally comparable diagnosis rather than a descriptive statement                         |
| 5    | Stratify refeeding risk before the first feed                                                                                | Body mass index below 16 kg/m <sup>2</sup> defines the highest risk stratum                                  |
| 6    | Calculate energy and protein targets from actual body weight and write a phased prescription                                 | Converts a screening result into an executable instruction with defined numbers                              |

|    |                                                                                     |                                                                                                                               |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| 7  | Commence thiamine before the first feed; add pyridoxine with isoniazid              | Both are inexpensive, low-risk and specifically indicated in this patient group                                               |
| 8  | Verify the antituberculosis dose against the actual weight band and re-band monthly | Milligram-per-kilogram exposure at low body weight determines both efficacy and toxicity                                      |
| 9  | Obtain baseline haemoglobin, and electrolytes where feasible                        | Anaemia predicts wasting and severity; electrolytes underpin refeeding safety                                                 |
| 10 | Review weight at the end of the intensive phase against a 5 per cent gain threshold | Failure to gain weight should trigger investigation for food insecurity, non-adherence, malabsorption, diabetes or resistance |
| 11 | Deliver tobacco cessation as part of tuberculosis treatment                         | Smoking increases the risk of poor outcome, recurrence and death                                                              |
| 12 | Reassess anthropometry at treatment completion and follow those still underweight   | Persistent underweight at completion carries elevated relapse risk                                                            |

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

This report describes a 73-year-old man with bacteriologically confirmed pulmonary tuberculosis presenting with severe protein-energy malnutrition at a body mass index of 13.8 kg/m<sup>2</sup>, a value at the extreme end of the distribution reported even within cohorts selected for undernutrition. The diagnosis of malnutrition was established formally rather than descriptively, satisfying all three phenotypic and both aetiological criteria of the Global Leadership Initiative on Malnutrition and grading as stage 2, severe. Formal nutritional assessment yielded a Mini Nutritional Assessment total of 15.5 of 30, and intrinsic-capacity screening identified an alert

confined to the nutrition domain, with cognition, locomotion, vision, hearing and psychological state all intact.<sup>4,5</sup>

Three conclusions follow from the case. The first is that undernutrition in this setting is not a passive comorbidity but a modifiable determinant of survival, treatment success and functional recovery. The evidence that nutritional depletion increases disease extent, delays sputum conversion, roughly doubles the risk of unsuccessful outcome and independently predicts death is now substantial, and the randomised evidence that nutritional support alters those outcomes is no longer speculative.<sup>8,17-19</sup>

The second is that a single anthropometric index is insufficient. In this patient the mid-upper arm circumference of 23 cm scored a full point on the corresponding Mini Nutritional Assessment item and generated no alert on the geriatric screening instrument, while the body mass index indicated undernutrition of extreme severity. Had either measure been used alone, the clinical picture would have been materially misrepresented, and the discordance observed here is consistent with published cut-off data in tuberculosis populations.<sup>28,29</sup>

The third is that the preservation of the five non-nutritional intrinsic-capacity domains, and the completion of the five-times chair-stand test within fourteen seconds despite profound compartmental depletion, identify this patient within a window in which functional decline has not yet followed body composition. That window is the argument for immediate rather than deferred nutritional intervention, and it is the principal clinical message of the case.<sup>31,39</sup>

Two aspects of the recorded prescription warrant correction before the intensive phase proceeds. The recorded four-tablet fixed-dose combination regimen corresponds to the 55 to 70 kg weight band and delivers milligram-per-kilogram doses above the accepted target range for all four agents at an actual weight of 40 kg, and pyridoxine prophylaxis, specifically indicated in a patient who is both elderly and undernourished, was not recorded. Neither observation diminishes the appropriateness of the diagnosis or of the decision to treat, but both bear directly on toxicity in this age group.

## **Recommendations**

### **Recommendations for Clinical Practice**

- Measure weight, height and mid-upper arm circumference in every patient at the point of tuberculosis diagnosis, and calculate body mass index rather than recording weight alone.
- Administer a validated geriatric nutritional instrument, such as the Mini Nutritional Assessment, in all patients aged 60 years and above, and record the total score in the clinical notes.
- Apply the GLIM criteria explicitly and state the severity grade, so that the nutritional diagnosis is internationally comparable rather than descriptive.
- Stratify refeeding risk before the first feed is given, recognising that a body mass index below 16 kg/m<sup>2</sup> places a patient in the highest risk stratum.
- Commence thiamine at 200 to 300 mg daily before the first feed and continue for at least ten days, together with multivitamin and trace element provision.
- Prescribe pyridoxine with isoniazid in every older or undernourished patient.
- Calculate energy and protein targets from actual body weight during the initial phases, and issue a phased written prescription with explicit numbers rather than general dietary advice.
- Verify the antituberculosis dose against the patient's actual weight band before initiation, re-measure weight monthly, and re-band the dose upward as weight is regained.
- Perform baseline and monthly visual acuity and colour vision assessment while ethambutol continues, and baseline and monthly transaminases during the intensive phase in older patients.
- Obtain baseline haemoglobin in every patient, and baseline phosphate, potassium and magnesium wherever the laboratory permits.
- Review weight at the end of the intensive phase against a five per cent gain threshold, and investigate food insecurity, non-adherence, malabsorption, undiagnosed diabetes and drug resistance where that threshold is not met.
- Deliver tobacco cessation counselling as a component of tuberculosis treatment rather than as generic health advice.

### **Recommendations for Service Organisation**

- Establish a defined local pathway linking a positive nutritional screen to a calculated nutritional prescription, since the absence of such a pathway, rather than the absence of instruments, is the principal barrier to implementation.
- Where daily electrolyte monitoring cannot be assured locally, arrange monitoring through a referral facility during the first week of refeeding, or consider short-term admission for initiation in patients at the highest risk stratum.
- Integrate SKILAS screening with tuberculosis case-finding in older adults, so that the two assessments occur at a single encounter rather than in separate programmes.
- Record nutritional metrics, including body mass index at initiation and at completion, as routine programme indicators alongside bacteriological outcomes.
- Extend nutritional support beyond the standard treatment duration for patients who remain underweight at completion, in view of their elevated relapse risk.

### **Recommendations for Further Research**

- Randomised evidence for nutritional intervention specifically in older adults with tuberculosis is lacking, since the landmark trials enrolled populations with mean ages in the fifth decade and did not report age-stratified nutritional outcomes.
- The optimal rate of energy escalation in older patients at very high refeeding risk remains undefined, with current recommendations derived largely from consensus and from cohorts that are neither age-specific nor tuberculosis-specific.
- Prospective evaluation is needed of whether combining anthropometry with a functional measure such as grip dynamometry improves prediction of tuberculosis treatment outcome beyond body mass index alone.
- The relationship between nutritional repletion during treatment and post-tuberculosis lung function warrants longitudinal study, given the association reported between pretreatment undernutrition and impaired spirometry at microbiological cure.
- Therapeutic drug monitoring studies are needed in severely undernourished adults to resolve the tension between reduced drug exposure at low body weight and increased toxicity risk at high milligram-per-kilogram dosing.

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## DECLARATIONS

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### Patient Consent

Informed consent for the publication of clinical details and accompanying images was obtained. Identifying information has been removed from the reproduced instruments where present.

### Ethical Considerations

This report describes routine clinical care delivered in accordance with national tuberculosis programme guidance. No intervention was undertaken for research purposes.

### Conflict of Interest

The author declares no conflict of interest.

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