**Association of Anemia with Rehabilitation Outcome for Subacute Geriatric Rehabilitation Patients in a Secondary Hospital in Malaysia**

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**Abstract**

**Objective**: To evaluate the effect of Anemia on Rehabilitation Outcome for Geriatric Subjects in Taiping Hospital Subacute Geriatric Rehabilitation Ward. **Methodology**: This was a retrospective study, with 126 subjects to compare the change in modified Barthel Index score of anemic and non anemic subjects. **Results**: 44% of subjects were anemic and the Mean corpuscular hemoglobin and Mean corpuscular volume for anemic subjects were 85.4pg and 29.8fL. Among anemic subjects 45.5% were Malay, 38.2% were Chinese, 14.5% were Indian and 1% were others. The Median (interquartile range) Modified Barthel Index on admission for anemic subjects and non anemic subjects were insignificantly difference which were 47 (29, 63) and 36 (21, 59) respectively, (p=0.059). The median (interquartile range) of Modified Barthel Index improvement for non anemic subjects was found to be significantly higher than anemic subjects which were 14 (5, 26) and 8 (1, 18) (p=0.021). Subject with hemoglobin ≥ 9g/dL were significantly associated with Modified Barthel Index improvement of more than 20, p=0.014. Multiple linear regression revealed a significant linear relationship between age and Modified Barthel Index score improvement (p=0.010). **Conclusion**:  The study suggested that non-anemic subjects showed significant Modified Barthel Index improvement. Our study also suggested judicious transfusion practices to maintain a hemoglobin threshold of 9 g/dL might be able to improve subject’s functional outcome. These results should encourage further research with a larger elderly subject population to provide insights and awareness for the need to correct anemia in rehabilitation subjects. **Keywords:** Geriatric, Anemia, Rehabilitation, Modified Barthel Index.

**INTRODUCTION**

Anemia is a common disease in the elderly population worldwide. According to WHO, definition of anemia is hemoglobin (hb) lower than 13 g/dL in men, Hb less than 12 g/dL in non-pregnant women, and less than 11g/dL in pregnant women [1]. In Malaysia, the prevalence of anemia among community dwelling older people age more than 60 was 35.3% [2]. Geriatric inpatient has higher anemia prevalence than community older people [3]. In Singapore, the anemia prevalence in geriatric inpatients is as high as 57% [4].

Anemia in the elderly is often under-recognized because they are usually presented with nonspecific symptoms such as tiredness and weakness, which are frequently assumed to be part of the ageing process. Awareness of the effects of anemia is rising as anemia in elderly have been shown to have poorer outcome in geriatric patients including increased risk of physical, cognitive impairment, functional, hospitalisation and mortality [3,5]. Hemoglobin level is associated with improvement of activity of daily living (ADL) for hospitalized patients [6-8]. Studies have shown that treating anemia in specific patient groups decreases their length of stay or improves their function [9-12]. A cohort study of postoperative hip fracture geriatric patients with higher hemoglobin level were independently associated with greater walking distance and functional recovery [13].

The hemoglobin threshold to trigger treatment for anemia has been debatable for elderly. Attempts were made to determine the optimal hemoglobin levels to guide management of anemia includes blood transfusion therapy. This strategy has been confounded by baseline function, hemoglobin level and additional co-morbidities including cardiovascular disease and risk of treatment. To the best of the authors’ knowledge, there is scanty evidence available to suggest hemoglobin ‘trigger’ for rehabilitation and recovery purpose. The published guidelines [14-32] acknowledged patients’ co-variables (including age) or others patient – specific criteria to be taken into consideration when making decision for blood transfusion therapy. Consensus was reached that transfusion may be of benefit when the hemoglobin is below 6 to 7g/dL. However, for those with hemoglobin above 10g/dL, transfusion is not beneficial mainly for mortality benefit. One of the strategies proposed for prudent transfusion strategy for elderly is to keep hemoglobin thresholds of 9–10 g/dL [33]. The aim of this study is to examine the effect of anaemia on rehabilitation outcome of patients in subacute geriatric rehabilitation ward.

**METHODS**

**Study Population**

Medical records of all subjects admitted to the subacute geriatric ward, Hospital Taiping from January 2018 until April 2019 were reviewed. Sample size was estimated using Open EPI software. Assumption was made that non anemic subjects might have a 20% improvement in MBI relative to subjects with anemic subjects. Preliminary unpublished data indicated that at least 20 subjects were needed in each group to demonstrate the assumption with a level of significance of 0.05 and a power of 80 percent. According to previous data, the ratio of anemic subjects without transfusion was calculated as 1:5. The total number of subjects to be investigated to obtain the final study population was 167. Subjects whose medical records were incomplete/missing their initial/final MBI (n=26), those who were younger than 60 years (n = 10), or those who did not have hemoglobin on admission, or 1 week prior or later (n=5) were excluded from the study. After accounting for these criteria, a total of 126 subjects were included in this study.

Subacute geriatric ward provides multidisciplinary treatment modalities to subjects including doctors, nurses, physiotherapists, occupational therapists, speech and language therapists, and dieticians. Selection of subjects from general ward to subacute ward were made by dedicated geriatric doctors who deemed subjects have good potential for recovery based on the local setting criteria. Upon admission, subjects were assessed by all team members for individualized plan. Daily physiotherapy or occupational therapy of at least 3 hours were provided for all suitable subjects. Subject's progress was reviewed and plan was discussed during the multidisciplinary team meeting which was held once per week until discharge.

**Hematological Test Results**

Hemoglobin levels and blood investigations results were collected on the admission day. If there were no blood investigations on admission, laboratory results a week prior to or after admission to the subacute ward, were traced from the Pathology Department. Anemia was defined according to the WHO criteria as hemoglobin concentration below than 12g/dL for women or below than 13g/dL for men [1].

**Functional Assessment**

Subjects’ functional status was assessed using a validated MBI by qualified occupational therapists on weekly basis until discharge. The items can be divided into two groups, one related to self-care (feeding, grooming, bathing, dressing, bowel and bladder care, and toilet use) and the other related to mobility (ambulation, transfers, and stair climbing). With a maximal score of 100, dependency levels are upgraded by every 20 score which include total dependency (0-19), very dependent (20-39), partial dependency (40-59), minimal dependency (60-79), and independency (80-100) [34]. We used cut-off point of 60 as it depicts the transition of subjects from dependency to assisted independency, with marked livelihood of living in the community [35].

**Statistical Analysis**

Statistical analysis was carried out by means of the IBM SPSS Statistics Version 21. Normally distributed data were compared with T Test and not normally distributed were compared with Fischer’s Exact and Mann-Whitney U Tests. Predictors for the outcome of the modified Barthel Index were analyzed by multiple linear regression. A cut-off points of p<0.05 was taken for statistical significance.

**RESULTS**

The demographic characteristics of the 126 subjects were summarised in Table 1 below. 44% (n=55) of subjects were anemic and they have higher creatinine level with a mean of 188umol/L and lower albumin level of 30.2g/dL as compared with non anemic subjects who had mean creatinine of 92.7umol/L and albumin of 36.2g/dL (p<0.001). (Table 2)

**Table 1**: Demographics of the study subjects (n=126)

|  |  |
| --- | --- |
|  | n (%) |
| **Age (years)**  60-69  70-79  80 and above | 44 (34.9)  42 (33.3)  40 (31.8) |
| **Sex**  Male  Female | 52 (41.3)  74 (58.7) |
| **Race**  Malay  Chinese  Indian  Others | 61 (48.4)  46 (36.5)  18(14.3)  1(0.8) |

The MBI for anemic subjects on admission was higher than non anemic subjects, but the difference was not significant (p=0.059). Both groups were mainly in the partially dependency category (MBI was within 40-59) [34]. The MBI improvement for non-anemic subjects was significantly higher in non-anemic subjects (p=0.021). Non anemic subjects have significant functional improvement of MBI > 20 compared with anemic patients, which were 27(38%) and 9(16.4%) respectively. However, there was insignificant different of achieving MBI > 60 upon discharge for anemic and non anemic subjects as mentioned in table 2.

**Table 2**: Variables comparison for anemic and non anemic subjects

|  |  |  |  |
| --- | --- | --- | --- |
|  | Anemic, n (%) | Non-anemic, n (%) | p-value |
| **Gender**  Male  Female | 17(30.9)  38(69.1) | 35(49.3)  36(50.7) | 0.036\* |
| **Race**  Malay  Chinese  Indian  Other | 25(45.5)  21(38.2)  8(14.5)  1(1.8) | 36(50.7)  25(35.2)  10(14.1)  0 | 0.770\* |
| **Biochemistry results**  **Mean(SD)**  WCC  Hb  MCV  MCH  Platelet  Creatinine  Albumin | 9.7(3.7)  10.0(1.6)  85.5(12.0)  29.8(9.5)  277.6(161.6)  188.9(171.5)  30.2(7.9) | 10.9(4.5)  14.0(1.2)  86.4(8.8)  29.9(6.4)  243.1(72.5)  92.7(49.6)  36.2(6.1) | 0.113  -  0.662  0.946  0.112  <0.001  <0.001 |
| **Charlson Comorbidity Index** | 5 (4, 7) | 5 (4, 6) | 0.031\*\* |
| **Clinical Frailty Scale** | 3 (3, 6) | 3 (3, 3) | <0.001\*\* |
| **Length of Stay (days)** | Median (IQR)  9 (6, 14) | Median (IQR)  11 (7, 15) | 0.166\*\* |
| **MBI Score**  On admission  On discharge  Score Improvement | Median (IQR)  47 (29, 63)  64 (39, 79)  8 (1, 18) | Median (IQR)  36 (21, 59)  60 (37, 78)  14 (5, 26) | 0.059\*\*  0.599\*\*  0.021\*\* |
| Subjects with MBI score improvement ≥20 (n(%)) | 9 (16.4) | 27 (38.0) | 0.008\*\*\* |
| Subjects with MBI score ≥60 at discharge (n(%)) | 26 (47.3) | 36(50.7) | 0.702\*\*\* |

(\*Fisher’s Exact Test, \*\*Mann-Whitney U Test, \*\*\*Pearson’s chi square)

Comparisons of MBI on admission, length of stay, clinical frailty scale and Charlson comorbidity index for subjects hemoglobin cut off value 9 g/dL as shown in Table 3. Hemoglobin above 9g/dL subjects were significantly associated with MBI improvement of more than 20 (table 4). The length of stay for both groups was not significantly different. Using simple logistic regression analysis, it was determined that age (p=0.005), MBI at presentation (p=0.006), and Hb level (p=0.004) significantly affect MBI improvement of more than 20 units whereas Charlson comorbidity Index and clinical frailty scale do not. Multiple logistic regression revealed a significant relationship between age and MBI score improvement (p=0.010), where subjects 10 years younger showed a 3.55 score improvement in MBI.

**Table 3:** MBI on admission, length of stay, clinical frailty scale and Charlson comorbidity index for subjects hemoglobin cut off value 9 g/dL

|  |  |  |  |
| --- | --- | --- | --- |
|  | Hemoglobin <9g/dl,  (n=15)  Median (IQR) | Hemoglobin ≥9g/dl,  (n=111)  Median (IQR) | p-value |
| MBI admission | 55 (39, 77) | 39 (25, 59) | 0.020\* |
| Charlson Comorbidity Index | 5 (4, 6) | 5 (4, 7) | 0.969\* |
| Clinical Frailty Scale | 3 (3, 7) | 3 (3, 4) | 0.107\* |
| Length of stay (days) | 8 (5, 14) | 10 (8, 15) | 0.097\* |
| MBI discharge ≥ 60 (n(%)) | 7 (46.6) | 55 (49.5) | 0.834\*\* |

(\* Mann-Whitney U Test, \*\* Pearson’s chi square)

**Table 4:** MBI improvement ≥20 and MBI improvement <20 for subjects hemoglobin cut off value 9 g/dL

|  |  |  |  |
| --- | --- | --- | --- |
|  | Hemoglobin <9g/dl,  n (%) | Hemoglobin ≥9g/dl,  n (%) | p-value |
| MBI improve ≥20 | 0 | 33 (29.7) | 0.014\* |
| MBI improve <20 | 15 (100%) | 78 (70.3) |

(\*Pearson’s chi square)

**DISCUSSION**

The prevalence of anemia in our study subjects was high (44%) and comparable to a large observational study [36] reported that the prevalence of anemia was 46.8% in hospitalised older subjects. Hospitalised elderly population had a higher prevalence of anemia than community living elderly population of 35.5% in Malaysia [2] because anemia was associated with higher comorbidity and poorer health status [3]. As shown in this study, anemic subjects had lower albumin, higher creatinine level, higher Charlson comorbidity index and higher clinical frailty scale significantly (table 2). The majority of anemic subjects had normocytic normochromic anemia. Previous study suggested that anemia in elderly adults were more likely due to chronic illness than nutritional deficiencies [37]. As this was a cross-sectional survey, causative relationships and aetiology of anemia could not be established.

The MBI on admission was found to be higher in anemic subjects than the non anemic subjects but it was insignificant. This finding was in contrast with anemia were associated with a higher number of impaired ADLs upon hospital admission in general ward [36]. However, Charlson comobidity index and clinical frailty scale were higher for the anemic subjects (Table 2). The possible explanation was clinician selection bias of subjects with presumed better recovery potential were more likely to be admitted to subacute geriatric ward for active rehabilitation. Nonetheless, both groups were mainly in partially dependency category (MBI was within 40-59) [34].

There was a significant MBI improvement for all subjects of median 10 (IQR 3, 23) (p<0.001) after treated with active rehabilitation. Number of subjects who were dependent (MBI <60) at admission was also reduced from 75.4% to 49.83% upon discharge (p<0.001) (not included in table). The mean length of stay was 11 days (±5.7). These findings supported the role of short rehabilitation in the subacute geriatric ward with multidisciplinary team approach being the key element for a successful rehabilitation. The time and effort invested was important to promote recovery and independence in elderly subjects with multiple comorbidity in order to reduce institutionalization of these subjects and to reduce caregiver burden.

Non anemic subjects had significantly higher MBI recovery than anemic subjects as shown in table 2 (p=0.021). The finding was comparable with a large observational study that anemic subjects have a lower rate of recovery than non anemic subjects, and anemia was associated with a substantially lower likelihood of regaining independence at hospital discharge [36]. Subgroup analysis showed a small number of subjects of Hemoglobin > 9g/dL had significantly higher MBI improvement ≥20 (P=0.014) as shown in table 4 and the finding was not confounded by Charlson comorbidity index and clinical frailty scale.

Moderate anemic (Hb 7.0-9.9 g/dl) subjects have few symptoms or no symptom at all, it is because of body homeostasis mechanisms that preserve tissue perfusion to vital organ. These homeostasis mechanisms include increased blood circulation due to reduced blood viscosity, increased oxygen supply to tissues due to raised red cell bisphosphoglycerate (2,3 BPG), increased plasma volume, and redistribution of blood flow [37]. In general, anemic subjects begin to experience symptoms of tiredness, shortness of breath and palpitation, only when the hemoglobin level is less than 7g/dL (about two-thirds of normal) as the basal cardiac output increases [38-40]. However, the elderly population especially those with cardiovascular disease may have impaired compensatory mechanisms. Elderly subjects with moderate anemia have lost the compensatory mechanism of tachycardia and increased cardiac output and resulted to be more passive and demotivated for active rehabilitation. This study suggested that the Hemoglobin threshold of 9 might be judicious for elderly subjects for MBI improvement of ≥ 20. However, higher hemoglobin target by liberal transfusion strategy to Hb at 11.3g/dl did not improve recovery of post operation of hip fracture frail elderly as demonstrated in a randomised controlled trial [38].

In this study, the non anemic or Hb >9g/dL subjects did not have significant functional improvement to become more livelihood of living in the community [35]. Nonetheless, they have significant functional improvement of MBI > 20 that might help to ease the caregiver burden and subjects’ quality of life.

**Limitation of the Study**

This was a retrospective study involving a small sample of subjects admitted in a subacute rehabilitation ward for geriatric patients, and was only a snapshot of the patients in a secondary referral hospital. There was also a risk of selection bias of subjects by clinician to admit subjects from acute treatment wards. There was no assessment of caregiver stress and patient quality of life.

**Conclusion**

A geriatric rehabilitation ward plays a significant role in facilitating selected good recovery subjects to become independent and likelihood of independent living in the community. In this study, non-anemic subjects showed significant MBI improvement. Our study also suggested judicious transfusion practices to maintain a hemoglobin threshold of 9 g/dL might be able to improve subject’s functional outcome. These results should encourage further research with a larger elderly subject population to provide insights and awareness for the need to correct anemia in rehabilitation subjects.

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**Authors’ contributions**

Conceptualization: ML Chin, WK Cheah. Methodology: ML Chin, CWS Chan, HE Chong. Formal analysis: ML Chin, CWS Chan. Project administration: ML Chin. Writing original draft: ML Chin. Writing review and editing: ML Chin, CWS Chan, HE Chong. Approval of final manuscript: all authors.

**Availability of data and materials**

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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**CONFLICTS OF INTEREST**

No potential conflicts of interest relevant to this article was reported.

**Ethics approval and consent to participate**

Ethics approval was obtained from Medical Research and Ethics Committee, Ministry of Health Malaysia (Ref: NMRR-19-1965-47705(IIR)).

**Consent for publication**

The manuscript has been read and approved for submission by all the named authors for open access publishing.

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