



## Serum Iron Studies as a Marker for Anaemia in Patients of Type 2 Diabetes Mellitus without Nephropathy

Authors

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### ABSTRACT

**Aim:** To study the presence of anaemia in patients with Type 2 DM without nephropathy and to use serum Iron studies as a marker for anaemia. In addition, the incidence and risk of anaemia were assessed according to age, gender, duration of diabetes and glycemic control status.

**Methods:** The study group consisted of 100 individuals with type 2 diabetes. Patients were divided on the basis of age, gender and duration of diabetes. Fasting and post prandial blood sugars and HbA1C for diabetic profiling, peripheral blood smear and serum Iron studies for anaemic profiling, serum urea and creatinine to rule out nephropathy, were evaluated.

**Results:** The study showed the prevalence of anaemia was present in 33% of study population. Normochromic normocytic (18%) was the most common type of anaemia amongst them with more female predominance(12%).The duration of diabetes was also associated with increase in incidence of anaemia. Blood sugar levels (fasting and post prandial), glycosylated haemoglobin and serum ferritin values were also significantly higher in anaemic group as compared to non-anaemic group whereas TIBC level and serum Iron was significantly lower in anaemic group as compared to non-anaemic group.

**Conclusion:** Our study suggested that poor glycemic control, longer duration of disease and old age are associated with increased incidence of anaemia in diabetic patients with normal renal function with normocytic normochromic anemia being the most common type. Another conclusion was that Serum ferritin can be considered as a sensitive marker of iron status and glycemic control in diabetics. So we would like to recommend that routine hematological tests along with blood glucose level and serum iron studies should be done mandatory in diabetic patients in order to give optimal treatment of anaemia in Type-2 diabetes mellitus which may have a potential to make a great impact in managing the various vascular complications of diabetes and thus improving the quality of life.

### INTRODUCTION

Diabetes is a highly disabling disease, which can cause blindness, amputations, kidney disease, anaemia, and cardiovascular and brain complications, among others, impairing the functional capacity and autonomy and individual quality of life<sup>1</sup>. It is a metabolic disorder of great

impact worldwide. It has indeed reached epidemic proportions worldwide affecting more than 415 million adults and is estimated to increase to 642 million by 2040<sup>2</sup>. Of these, more than 95% have type 2 diabetes mellitus (T2DM). India is one of the epicenters of the global diabetes mellitus epidemic and has the highest number of people

with the disease in the world<sup>3</sup>. The ICMR is currently undergoing the ICMR–India Diabetes (ICMR–INDIAB) study which aims to estimate the prevalence of diabetes mellitus in individuals from rural and urban areas of all 29 states of India. Phase 1 studies covering four states of the country (Tamil Nadu, Maharashtra, Jharkhand and Chandigarh) show, that till 2011, 62 million individuals had diabetes mellitus and 77 million had prediabetes<sup>4</sup> (that is, impaired glucose tolerance and impaired fasting glucose according to the WHO criteria). People originating from the Indian subcontinent have a specific phenotype, characterized by high levels of intra-abdominal fat and insulin resistance in spite of a low BMI (Body Mass Index). This predisposes them to T2DM and premature coronary heart disease<sup>5</sup>. This signifies the importance of learning about the patterns and behavior of diabetes mellitus in this ethnic group.

Anaemia is a condition in which the number of red blood cells or the oxygen carrying capacity is insufficient to meet physiological needs, which vary by age, sex, altitude, smoking and pregnancy status. The World Health Organization (WHO) defines anaemia as haemoglobin levels below 13 g/dl in males and 12 g/dl in females. Iron Deficiency is thought to be the most common cause of anaemia globally, although other conditions such as folate, Vitamin B12 deficiencies, chronic inflammation, parasitic infections and inherited disorders can all cause anaemia.

The etio-pathogenesis of anaemia in diabetes is multifactorial. Erythropoietin (EPO) deficiency as a result of DN is the most important cause of anaemia in patients with diabetes<sup>6</sup>. However, even before any functional or organic deficiency of EPO is evident, several other factors, may contribute to the development of a chronic hypoxic stimuli, promoting erythropoietic stress and potentiating the genesis of early anaemia in diabetes<sup>7-9</sup>. Also, low levels of testosterone, a common finding in males with type 2 diabetes, may contribute to anaemia in these patients.<sup>10</sup> Patients with diabetes have a greater degree of anaemia for their level of renal impairment than

non-diabetic patients presenting with other causes of renal failure. This may explain why most diabetic patients with normal renal function are rarely tested for anaemia. In spite of the plethora of reports on the presence of anaemia in diabetic patients with renal insufficiency, limited study exists on the incidence of anaemia in diabetics prior to the evidence of renal impairment.

Many observational studies show that having anaemia along with diabetes increase the likelihood of developing diabetic retinopathy, heart disease or stroke and people who have both diabetes and anaemia are more likely to die early than those who have diabetes but not anaemia.

Under these circumstances, anaemia in patients with diabetes must be treated once diagnosed, since it may contribute to the pathogenesis and progression of microvascular and macrovascular complications. We believe such knowledge may help patients ascertain the impact of anaemia and lead to opportunities for developing interventions to optimize outcomes in diabetic patients. The need for more studies on incidence of anaemia in diabetic patients prior to renal impairment has therefore become imperative, in order to increase the level of awareness and understanding of anaemia amongst diabetic patients.

To clarify the contribution of diabetes to anaemia in patients with type 2 diabetes, we examined the hematologic and hematinic parameters of diabetic patients without nephropathy and aimed at demonstrating the incidence and risk of anaemia in type-2 diabetic patients with normal renal function.

## METHODS

### Subjects

This prospective observational study was conducted on 100 Type 2 DM individuals (both inpatient and outpatient) at MGM Medical College Hospital, Kamothe from August 2014 to December 2016 in patients reporting to the hospital with Type 2 DM for treatment.

Patients with Type 1 DM, hemolytic anaemia or hemoglobinopathies were excluded from the

study. Also the patients who were on treatment for anaemia, those who have donated or received blood transfusion or with associated co-morbid conditions like hypertension, congestive heart failure, chronic renal failure, stroke and malignancy were also excluded from the study.

In all patients, detailed clinical history was obtained using a pre-tested Performa and a detailed systemic examination was conducted.

Blood samples were collected using aseptic precautions and following investigations were undertaken: complete blood count by standard method, urine analysis by standard microscopy method, blood glucose (both fasting and postprandial) by glucose oxidase method, peripheral blood smear by microscopy, iron profile by ferrozine iron method, glycosylated hemoglobin by Ion Exchange Resin method and serum creatinine by Jaffe’s Kinetic method.

Statistical analysis: Qualitative data was presented as frequency and percentages and analyzed using chi-square test or fisher’s exact test (in case of 2x2 contingency tables). Quantitative data was presented as mean and SD and compared by unpaired t-test or Man Whitney U test (in case of non-normal distribution). The level of significance was set at p=0.05. We utilized SPSS 20.0 for Windows for all examinations.

**RESULTS**

In the present study conducted, following results were obtained:

- 1) The most common age group amongst study population was 51-60 years (37%) followed by 61-70 years (27%) and 20 individuals (20%) were in the group of 41-50 years.
- 2) The study had more number of females (56%) than males (44%).
- 3) Most of the study population had more than 15 years of duration of diabetes (36%) followed by less than 5 years (35%) and then between 5 to 10 years (25%)
- 4) Urine sugar was present in 68 % of study population on urine routine examination and absent in the rest.
- 5) The prevalence of anaemia was present in 33% of study population whereas 67% of the population was non anaemic.
- 6) Normochromic normocytic (18%) was the most common type of anaemia amongst study population followed by hyperchromic microcytic (9%) and hypochromic macrocytic (6%).
- 7) Normochromic normocytic anaemia, hyperchromic microcytic anaemia and hypochromic macrocytic anaemia was present in 57.1%, 28.6% and 14.3% of female population respectively while in males it was present in 50.0%, 25% and 25% respectively. There was no statistically significant difference between type of anaemia and gender distribution.

**Table no 1** Comparison of type of anaemia amongst different gender

			Sex		Total
			Female	Male	
Type of anaemia	Hypo chromic macrocytic	Count	3	3	6
		% within Sex	14.3%	25.0%	18.2%
	Hyper chromic microcytic	Count	6	3	9
		% within Sex	28.6%	25.0%	27.3%
	Normochromic normocytic	Count	12	6	18
		% within Sex	57.1%	50.0%	54.5%
Total		Count	21	12	33
		% within Sex	100.0%	100.0%	100.0%

Chi square value – 0.589, df- 2, P value – 0.745.

8) The most common anaemia in patients with diabetes for 5 – 10 years were normochromic normocytic anaemia (42.9%) and hypochromic macrocytic anaemia (42.9%).

In patients with diabetes for 11 -15 years the most common anaemia were normochromic normocytic anaemia (75%) and hyperchromic macrocytic anaemia (25%)

In patients with diabetes for more than 15 years, the most common anaemia was normochromic normocytic anaemia (54.5%) and Hyperchromic macrocytic anaemia (31.8 %) There was no statistically significant difference between the type of anaemia and duration of DM.

**Table no 2** Comparison of type of anaemia (anaemic patients) amongst different duration of DM

			Duration of DM			Total
			5 -10 yrs	11 - 15 yrs	> 15 yrs	
Type of anaemia	Hypochromic macrocytic	Count	3	0	3	6
		% within Duration of DM	42.9%	0.0%	13.6%	18.2%
	Hyperchromic microcytic	Count	1	1	7	9
		% within Duration of DM	14.3%	25.0%	31.8%	27.3%
Normochromic normocytic	Count	3	3	12	18	
	% within Duration of DM	42.9%	75.0%	54.5%	54.5%	
Total	Count	7	4	22	33	
	% within Duration of DM	100.0%	100.0%	100.0%	100.0%	

Chi square value – 4.41, df- 4, P value – 0.353

9) There was no statistically significant difference in age, WBC and platelet count in anaemic vs non anaemic study

population while significant difference was in hemoglobin level.

**Table no 3** Various other parameters amongst different study population (Anaemic Vs Non anaemic)

Other parameters	Anaemic		Non anaemic		P value
	Mean	Std. Deviation	Mean	Std. Deviation	
Age	59.82	9.419	58.69	9.605	0.57
WBC	8396.67	2209.919	8930.75	2261.786	0.26
Platelet	137030.30	73438.424	157208.96	93961.555	0.28
Hemoglobin	8.95	0.874	11.99	0.856	0.0001

10) Blood Sugar Level (fasting and post prandial) and HbA1 C was higher in anaemic group as compared to non

anaemic group and this difference was statistically significant.

**Table no 4** Blood Sugar and HbA1 C Levels amongst different study population (Anaemic Vs Non anaemic)

	Anaemic		Non anaemic		P value
	Mean	Std. Deviation	Mean	Std. Deviation	
Blood Sugar Level ( Fasting)	155.94	49.969	99.42	39.901	0.0001
Blood Sugar Level ( Post prandial)	208.76	52.467	129.94	25.362	0.001
HbA1 C	9.12	0.740	7.90	0.721	0.001

11) Serum ferritin levels were significantly higher in anaemic group as compared to non anaemic group while TIBC level and

serum Iron were significantly lower in anaemic group as compared to non anaemic group.

**Table no 5** Serum ferritin, TIBC and Serum Iron Levels amongst different study population (Anaemic Vs Non anaemic)

	Anaemic		Non anaemic		P value
	Mean	Std. Deviation	Mean	Std. Deviation	
Serum Ferritin	326.75	45.839	61.55	22.424	0.001
TIBC	107.33	16.573	305.31	26.680	0.001
Serum Iron	40.12	6.882	102.88	33.706	0.001

## DISCUSSION

Diabetes is considered a major cause of premature death, because of the increased risk for developing cardiovascular diseases, which contribute to 50% to 80% of patient's death. The incidence of cardiovascular diseases reaches 20% in diabetics after a period of about 7 years<sup>11</sup>.

In the present study, the prevalence of anaemia in T2DM was 33%. Similarly in the study conducted by Subashini Thambiah et al., the prevalence of anaemia in T2DM was 39.4%.<sup>12</sup>

In the present study, 51-60 years (37%) was the most common age group amongst study population followed by 61-70 years (27%) with the mean age of  $59.06 \pm 9.5$  years. This finding is in agreement with the study conducted by Gunvanti B. Rathod et al., in which the mean age was  $59 \pm 13$  years respectively<sup>13</sup>. Similar findings were observed by Jéssica Barbieri et al., 2015 in which the study population had an average age of  $60.9 \pm 8.9$  years<sup>14</sup>.

In the present study, there was female predominance (56%) amongst study population which correlates well with the study conducted by Al-Salman M, 2015 in which females contributes 55.55% while males contribute 44.4% of study population<sup>15</sup>. Similarly in the study conducted by Ayesha Sharif et al., the incidence of anemia was higher in diabetic female (36%) as compared to diabetic male population (27%)<sup>16</sup>.

In the present study, 61% of the study population had diabetes for more than 5 years which is in agreement with the study conducted by Gunvanti

B. Rathod et al., in which 58.5% had duration of diabetes for than 5 years<sup>13</sup>.

In the present study, normochromic normocytic (18%) was the most common type of anaemia amongst study population followed by hyperchromic microcytic (9%) and Hypochromic macrocytic (6%). These findings correlate well with the study conducted by Ayesha Sharifin et al., in which (26%) had normocytic normochromic anaemia while (15.5%) had microcytic hypochromic anaemia<sup>16</sup>.

In the present study, blood sugar Levels and HbA1C were higher in Anaemic group as compared to Non anaemic group and this difference was statistically significant similar to the study conducted by Borah M et al., in which it was also observed that serum ferritin levels showed a positive correlation with HbA1c%, that was statistically highly significant ( $p < 0.01$ )<sup>17</sup>.

In the present study, Serum Ferritin level was significantly higher in anaemic group as compared to non anaemic group while TIBC level and Serum Iron was significantly lower in Anaemic group as compared to Non anaemic group. In a study carried out by Smotra S, et al., in a tertiary care hospital similar results were found that in those with increased level of Serum Ferritin, more number of patients had poor glycemc control reflected by higher levels of HbA1c % as compared to those with normal levels and was found to be statistically significant ( $p < 0.05$ )<sup>18</sup>.

A study carried out in Korea University Hospital from 1997 to 1998 by Kim et al showed that the value of serum ferritin was higher in the type 2

diabetes patients than the control subjects<sup>19</sup>. They concluded that serum ferritin can be employed as a marker of not only glucose homeostasis but also insulin resistance both in type 2 diabetic and control subjects.

Canturk Z et al also confirmed in their studies that poorly controlled diabetes patients, reflected by higher HbA1c%, had hyperferritinemia<sup>20</sup>. This showed that serum ferritin was increased in diabetes as long as glycemic control was not achieved.

Although the exact mechanism for association of elevated serum ferritin with type 2 diabetes mellitus is yet to be established, there are a number of prevailing theories. Iron overload is believed to be associated with insulin resistance. Iron deposition in the liver may cause insulin resistance by interfering with the ability of insulin to suppress hepatic glucose production. Pancreatic damage due to some degree of subclinical hemochromatosis has been considered at least in some cases of diabetes.

Iron is auto-oxidized to form highly reactive, lipid soluble iron-oxygen complexes. These free radicals are powerful pro-oxidants, which can change membrane properties and result in tissue damage<sup>21,22</sup>. Oxidative stress can also lead to hyperglycemia through disturbed glucose metabolism. Conversely, insulin stimulates cellular iron uptake through increased transferrin receptor externalization. Insulin resistance coupled with poor glycemic control can also increase ferritin levels. Thus, insulin and iron can mutually potentiate their effects leading after a vicious cycle to insulin resistance and diabetes. It has been established that diabetic autonomic neuropathy is a major complication of poor glycemic control.<sup>23</sup>

Currently, the TREAT (Trial to Reduce Cardiovascular Events with Aranesp Therapy) study is being carried out to study the impact on mortality and nonfatal cardiovascular events in patients with type 2 DM of anaemia correction to high (haemoglobin 13 g/dl) and low (haemoglobin 9 g/dl) levels.<sup>24</sup> Another multicentre study,

ACORD (Anaemia Correction in Diabetes)<sup>25</sup> studied the effects of anaemia correction on cardiac structure, function, and outcomes in patients with diabetes with anaemia. The primary results from ACORD reported that in patients with diabetes with mild to moderate anemia and moderate left ventricular hypertrophy, correction to an Hb target level of 13 to 15 g/dL (130 to 150 g/L) does not decrease LVMI. However, normalization of Hb level prevented an additional increase in left ventricular hypertrophy, was safe, and improved quality of life. On completion, TREAT may provide us a better insight into the benefits of anaemia and hence, a better understanding of the role of anaemia in the progression of vasculopathy in DM.

## CONCLUSION

In conclusion, some incidence of anaemia was observed in the patients without renal insufficiency in our study. Our Data also suggested that poor glycemic control, longer duration of disease and old age are associated with increased incidence of anaemia in diabetic patients with normal renal function.

Reduction of blood glucose levels and the targeting of acceptable glycated hemoglobin levels would help reduce the risk of anaemia in the diabetic population. There is an urgent need for proper diabetic care and management for old diabetic, who have limited food choices and are more vulnerable to anaemia. So we would like to recommend that routine hematological tests along with blood glucose level should be mandatory in diabetic patients in order to make optimal therapeutic decisions for treatment of anaemia in type-2 diabetes mellitus which may have a potential to make a great impact in managing the various microvascular as well as macrovascular complications of diabetes and thus improving the quality of life. Until the results of TREAT study is awaited and in absence of clear guidelines on anaemia management in diabetes, it would be fairly reasonable to aim to maintain the

haemoglobin levels between 10.5 and 12.5 g/dl as recommended by NICE.<sup>26</sup>

As seen in the study, poorly controlled diabetic patients had higher levels of serum ferritin indicating that ferritin levels positively correlate with poor glycemic control as reflected by elevated HbA1C and hence it can be used as marker for glycemic control.

Serum ferritin can be considered as a sensitive marker of iron status in diabetics. Undue prescription of iron and folic acid supplements for anaemia in Type 2 DM should be avoided before doing iron studies and knowing the type of anaemia as it may result in iron overload and further complications.

Additional elaborate randomized clinical trials are required to shed greater light in this aspect.

## REFERENCES

1. Francisco, Priscila Maria Stolses Bergamo, Ana Paula Belon, Marilisa Berti de Azevedo Barros, Luana Carandina, Maria Cecília Goi Porto Alves, Moises Goldbaum, and Chester Luiz Galvão Cesar. “[Self-reported diabetes in the elderly: Prevalence, associated factors, and control practices].” *Cadernos de Saude Publica* 26, no. 1 (Jan 2010): 175–84.
2. International Diabetes Federation. *IDF Diabetes Atlas*. seventh edition 2015, 2015. [online].
3. Arokiasamy, P., S. Parasuraman, T. V. Sekher, and H. Lhungdim. *India: Study on global Ageing and adult health (SAGE), Wave 1. International Institute for Population Sciences*. Geneva: World Health Organization, 2013.
4. Prevalence of diabetes and prediabetes Anjana RM, Pradeepa R, Deepa M, Datta M, Sudha V, Unnikrishnan R, Bhansali A, Joshi SR, Joshi PP, Yajnik CS, Dhandhanika VK, Nath LM, Das AK, Rao PV, Madhu SV, Shukla DK, Kaur T, Priya M, Nirmal E, Parvathi SJ, Subhashini S, Subashini R, Ali MK, Mohan V for the ICMR– INDIAB Collaborative Study Group.
5. Mohan, V., and G. H. R. Rao. *Type 2 Diabetes in South Asains*. 1st ed. New Delhi: South Asian Society on Atherosclerosis and Thrombosis, 2007.
6. Winkler, A. S., J. Marsden, K. R. Chaudhuri, H. Hambley, and P. J. Watkins. “Erythropoietin depletion and anaemia in diabetes mellitus.” *Diabetic Medicine* 16, no. 10 (Oct 1999): 813–9.
7. Spannhaake, E. W., and J. W. Fisher. “Partial inhibition of hypoxia-induced erythropoietin production by cholinergic blockade in the dog (39866).” *Proceedings of the Society for Experimental Biology and Medicine* 156, no. 1 (Oct 1977): 19–23.
8. Takaku, F., K. Hirashima, and S. Okinaka. “Effect of the bilateral section of the splanchnic nerve on erythropoiesis.” *Nature* 191, no. 4787 (Jul 29, 1961): 500–1.
9. Biaggioni, I., D. Robertson, S. Krantz, M. Jones, and V. Haile. “The anemia of primary autonomic failure and its reversal with recombinant erythropoietin.” *Annals of Internal Medicine* 121, no. 3 (Aug 1, 1994): 181–6.
10. Corona, G., M. Monami, G. Rastrelli, A. Aversa, A. Sforza, A. Lenzi, G. Forti, E. Mannucci, and M. Maggi. “Type 2 diabetes mellitus and testosterone: A meta-analysis study.” *International Journal of Andrology* (October 24, 2010). <https://doi.org/10.1111/j.1365-2605.2010.01117.x>.
11. Silva, T. R., J. Zanuzzi, C. D. M. Silva, X. S. Passos, and B. M. F. Costa. “Prevalence of cardiovascular diseases in diabetic and nutritional status of patients.” *Journal of the Health Sciences Institute* 30, no. 3 (2012): 266–70.
12. Subashini Chellappah Thambiah, M. M. “Intan Nureslyna Samsudin, Elizabeth

- George ....” *Malaysian Journal of Medicine and Health Sciences* 11, no. 1 (2015): 49–62.
13. Rathod, G. B., P. Parmar, S. Rathod, and A. Parikh. “Study of Dyslipidemic Pattern and Glycosylated Hemoglobin Status in Diabetic Patients.” *Endocrinol Diabetes Res* 1, no. 01 (2015): 1.
14. Anemia in Patients with Type 2 Diabetes Mellitus Jéssica Barbieri et.al. Hindawi Anemia Volume 2015 (2015), Article ID 354737, 7 pages <http://dx.doi.org/https://doi.org/10.1155/2015/354737>.
15. Salman, M. A. “Anemia in Patients with Diabetes Mellitus: Prevalence and Progression.” *General Medicine (Los Angeles, Calif.)* 3 (2015): 162.
16. Sharif, A., S. Younus, K. Baig, and N. Ali. “Prevalence and Risk of Anemia in Type-2 Diabetic Patients.” *Health* 6, no. 12 (2014): 1415–9.
17. International Journal of Research in Medical Sciences Borah M et al. *Int J Res Med Sci.* 2016 Nov;4(11):4916-4921 [www.msjonline.org](http://www.msjonline.org) pISSN 2320-6071 | eISSN 2320-6012
18. Smotra, S., and R. P. Kudyar. “Relationship between Serum Ferritin and Type-2 Diabetes Mellitus.” *JK Science.* 10, no. 4 (2008): 170.
19. Kim, N. H., J. H. Oh, K. M. Choi, Y. H. Kim, S. H. Baik, D. S. Choi, and S. J. Kim. “Serum ferritin in healthy subjects and type 2 diabetic patients.” *Yonsei Medical Journal* 41, no 3 (Jun 2000): 387–92.
20. Canturk, Zeynep, Berrin Cetinarslan, Ilhan Tarkun, and Nuh Zafer Canturk. “Serum ferritin levels in poorly- and well-controlled diabetes mellitus.” *Endocrine Research* 29, no. 3 (Aug 2003): 299–306.
21. Oberley, L. W. “Free radicals and diabetes.” *Free Radical Biology & Medicine* 5, no. 2 (1988): 113–24.
22. Wolff, S. P. “Diabetes mellitus and free radicals. Free radicals, transition metals and oxidative stress in the aetiology of diabetes mellitus and complications.” Cite this article as: Borah M, Gosw. *British Medical Bulletin* 49, no. 3 (Jul 1993): 642–52.
23. Fernández-Real, José Manuel, Abel López-Bermejo, and Wifredo Ricart. “Iron stores, blood donation, and insulin sensitivity and secretion.” *Clinical Chemistry* 51, no. 7 (Jul 2005): 1201–5.
24. Genuth, S., and F. Ismail-Beigi. “Clinical implications of the ACCORD trial.” *Journal of Clinical Endocrinology and Metabolism* 97, no. 1 (Jan 2012): 41–8.
25. Locatelli, Francesco, Pedro Aljama, Bernard Canaud, Adrian Covic, Angel De Francisco, Iain C Macdougall, Andrzej Wiecek, and Raymond Vanholder, and the Anaemia Working Group of European Renal Best Practice (ERBP). “Target haemoglobin to aim for with erythropoiesis-stimulating agents: A position statement by ERBP following publication of the Trial to reduce cardiovascular events with Aranesp therapy (TREAT) study.” *Nephrology, Dialysis, Transplantation* 25, no. 9 (Sep 2010): 2846–50.
26. National Institute for Health and Care Excellence - NICE