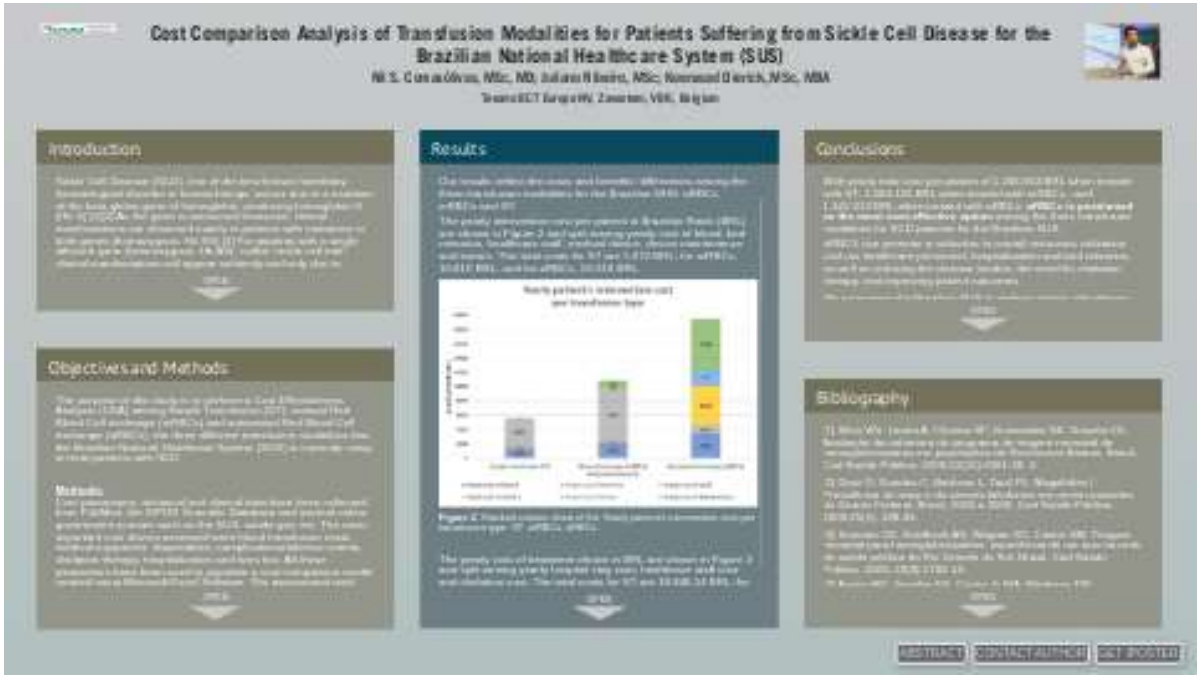
Cost Comparison Analysis of Transfusion Modalities for Patients Suffering from Sickle Cell Disease for the Brazilian National Healthcare System (SUS)



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PRESENTED AT:

INTRODUCTION

Sickle Cell Disease (SCD), one of the best known hereditary hematological disorder in human beings, occurs due to a mutation of the beta globin gene of hemoglobin, producing hemoglobin S (Hb S).[1][2] As the gene is autosomal recessive, clinical manifestations are observed mainly in patients with mutations in both genes (homozygous: Hb SS).[3] For patients with a single affected gene (heterozygous: Hb AS), called “sickle cell trait”, clinical manifestations will appear seldomly and only due to exposure to extreme conditions of low oxygen tension (e.g. strenuous physical exertion, high altitude environments,…).[4]

SCD, originally from Africa, was brought to the Americas by the forced immigration of slaves and, thus, it is more frequent where the population has a higher proportion of African descendants (northeastern region and the States of Rio de Janeiro, São Paulo and Minas Gerais).[5][6][7]

In Brazil around 2.500 neonates will be born yearly with SCD (Hb SS),[5][6] and it is considered that at least 50.000 Brazilian citizens have SCD.[8]

Red blood cell (RBC) transfusion is one of the mainstays of long-term SCD therapy together with hydroxyurea therapy. It is supported by multiple randomized clinical trials for the prevention of disease complications such as stroke, both in adults and children with SCD, acute splenic sequestration, acute chest syndrome, etc.[9][10]

To avoid and overcome significant SCD complications, treating physicians have different transfusion modalities such as automated Red Blood Cell exchange (aRBCx), manual Red Blood Cell exchange (mRBCx) and Simple “top-up” Transfusion (ST).[11]

In ST, patients get transfusions of units of blood that will increase oxygen-carrying capacity but with a risk of hyperviscosity as sickle red blood cells will remain in the bloodstream. In RBCx, sickle red blood cells are replaced with healthy ones, thus increasing oxygen-carrying capacity, reducing the proportion of sickle hemoglobin and, hence, avoiding hyperviscosity and related adverse events.[11] RBCx is recommended over ST as it avoids or minimizes the iron chelation therapy to treat iron overload and might reduce the incidence of other events such as acute ischemic stroke.[11][12][13]

OBJECTIVES AND METHODS

The purpose of this study is to perform a Cost Effectiveness Analysis (CEA) among Simple Transfusion (ST), manual Red Blood Cell exchange (mRBCx) and automated Red Blood Cell exchange (aRBCx), the three different transfusion modalities that the Brazilian National Healthcare System (SUS) is currently using to treat patients with SCD.

Methods:

Cost parameters, technical and clinical data have been collected from PubMed, the ISPOR Scientific Database and several online government sources such as the SUS, saude.gov, etc. The most important cost drivers assessed were blood transfusion costs, medical equipment, disposables, complications/adverse events, chelation therapy, hospitalization and lives lost. All these parameters have been used to populate a cost comparison model created using Microsoft Excel Software. The assessment took place in July 2020.

Due to the broad range of adverse events and complications linked to SCD, 14 of the most common ones found in scientific publications with an economic impact for the healthcare system have been included and are portrayed in Figure 1.

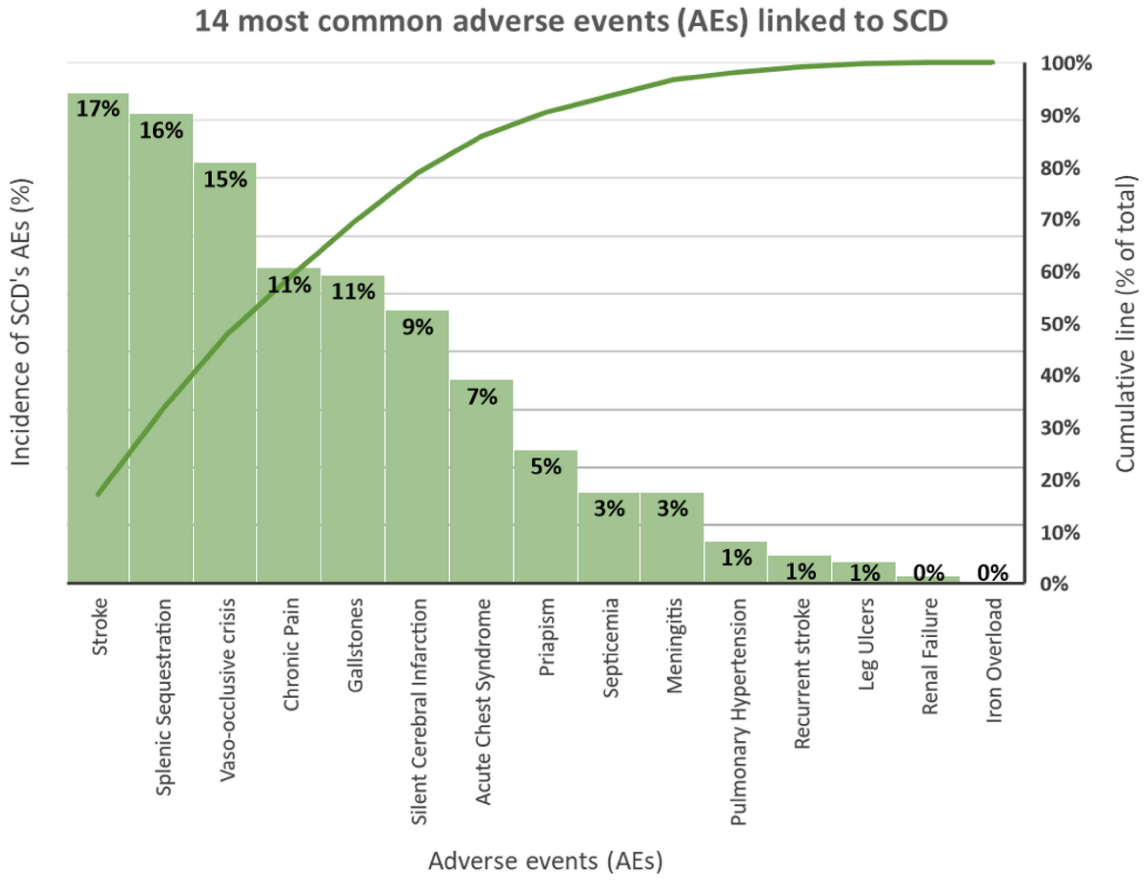

Figure 1. Pareto chart of the 14 most common AEs linked to SCD.
Stroke, Splenic sequestration, Vaso-occlusive crisis, Chronic pain, Gallstones and Silent cerebral infarction amount to more than 80% of the adverse events linked to SCD.

RESULTS

Our results reflect the costs and benefits' differences among the three transfusion modalities for the Brazilian NHS: aRBCx, mRBCx and ST.

The yearly intervention cost per patient in Brazilian Reals (BRL) are shown in Figure 2 and split among yearly cost of blood, bed retention, healthcare staff, medical device, device maintenance and extra's. The total costs for ST are 5.672 BRL; for mRBCx, 10.810 BRL; and for aRBCx, 19.519 BRL.

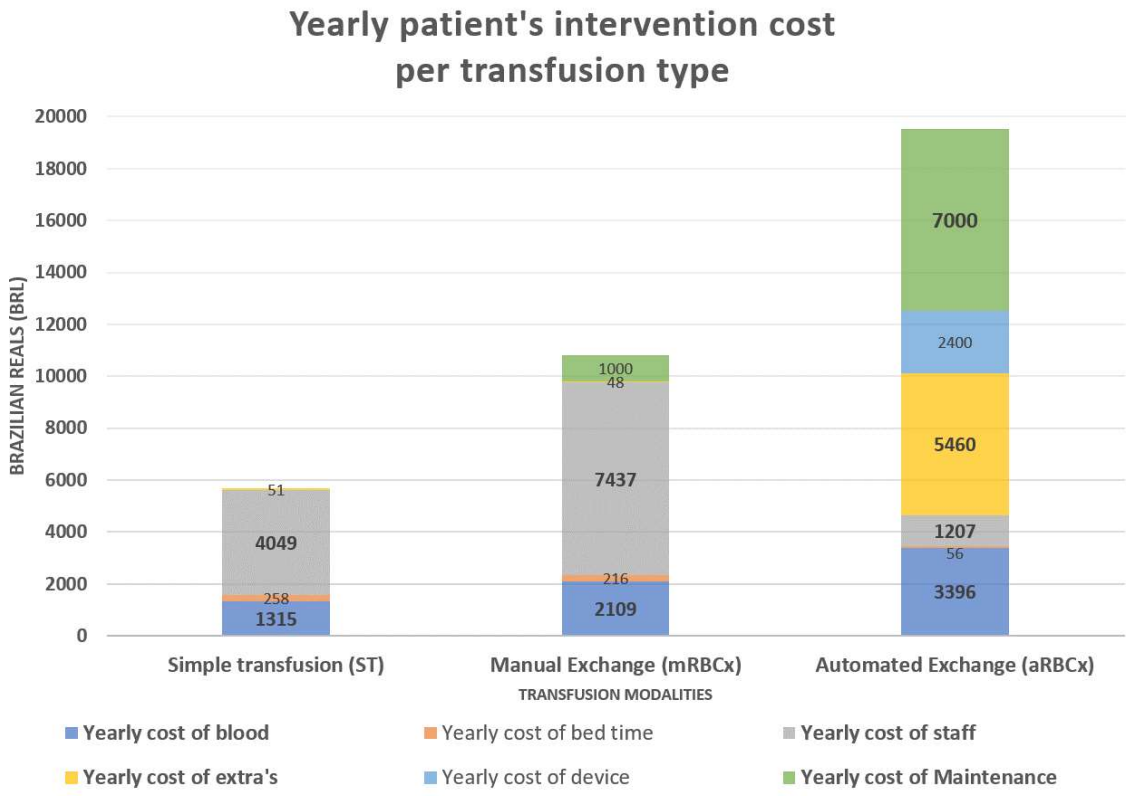

Figure 2. Stacked column chart of the Yearly patient's intervention cost per transfusion type: ST, mRBCx, aRBCx.

The yearly cost of treatment choice in BRL are shown in Figure 3 and split among yearly hospital stay cost, healthcare staff cost and chelation cost. The total costs for ST are 18.846,54 BRL; for mRBCx, 14.141,36 BRL; and for aRBCx, 7.536,69 BRL.

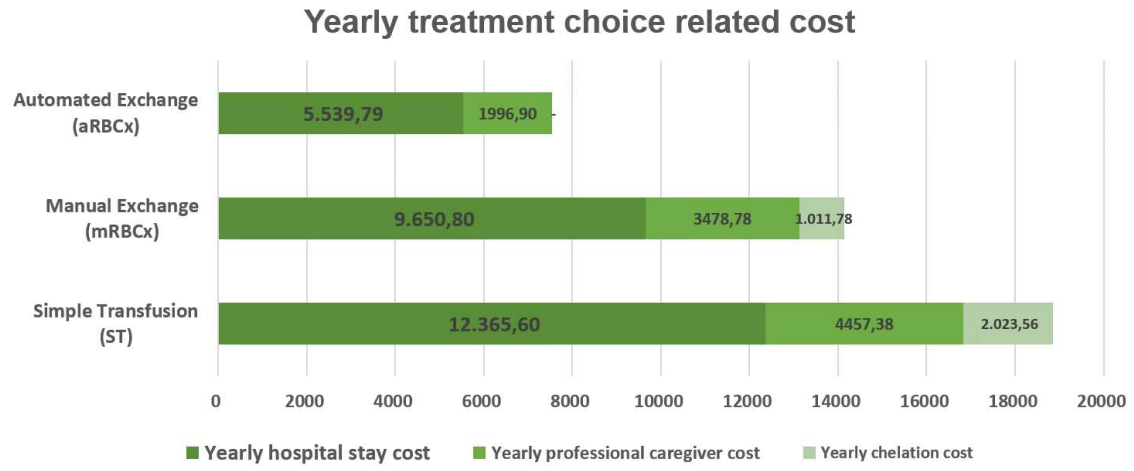

Figure 3. Stacked bar chart of the yearly cost of treatment choice per transfusion type: ST, mRBCx and aRBCx.

The yearly cost of disease complications in BRL are shown in Figure 4. The total costs for ST are 178.441 BRL; for mRBCx, 180.667 BRL; and for aRBCx, 159.344 BRL.

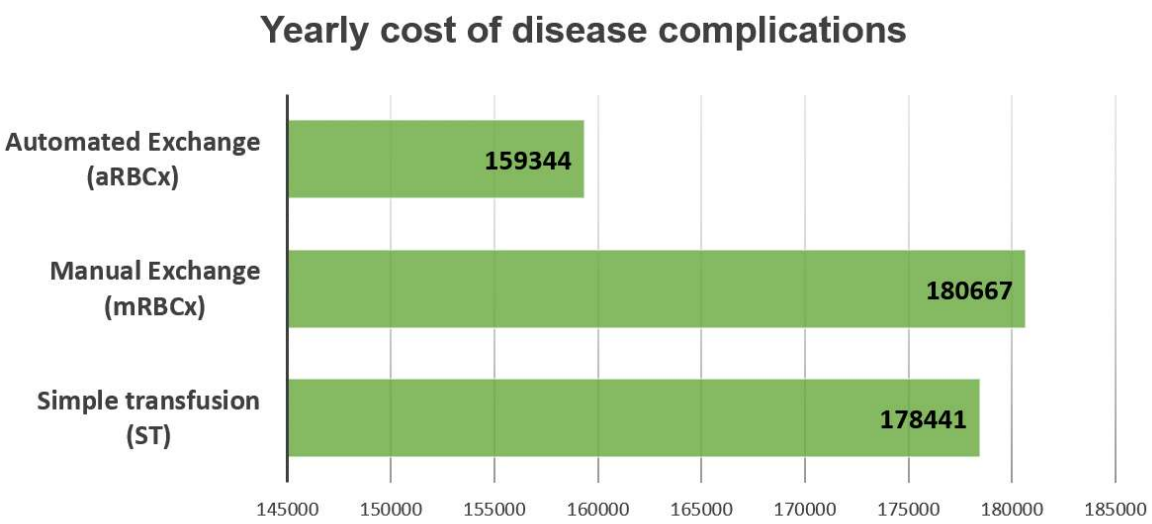

Figure 4. Clustered bar chart of the yearly cost of disease complications per transfusion type: ST, mRBCx and aRBCx.

The yearly average contribution per disease complication to total costs are shown in Figure 5. Although there are quantitative differences among transfusion modalities related to disease complications, the largest variance amounted to only ± 3%.

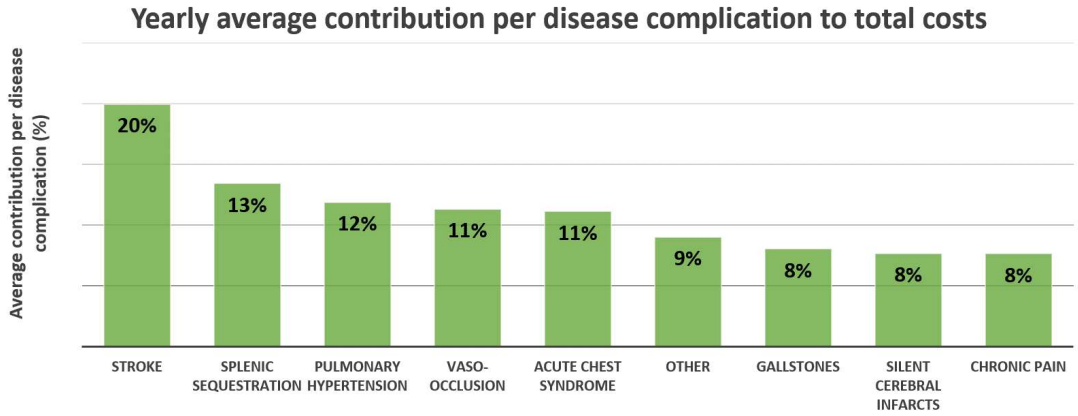

Figure 5. Clustered column chart of the yearly average contribution per disease complication to total costs. Stroke and Splenic sequestration are the disease complications with the highest contribution to total costs.

The yearly cost of lives lost per patient in BRL for ST are 7.172 BRL; for mRBCx, 7.072 BRL; and for aRBCx, 6.005 BRL.

The yearly total cost per patient estimated in BRL are shown in Figure 6 and include yearly intervention cost per patient, yearly treatment choice related costs, yearly total cost of disease complications, and total cost of lives lost per patient. The total costs for ST are 1.268.963 BRL; for mRBCx, 1.284.126 BRL; and for aRBCx, 1.161.913 BRL.

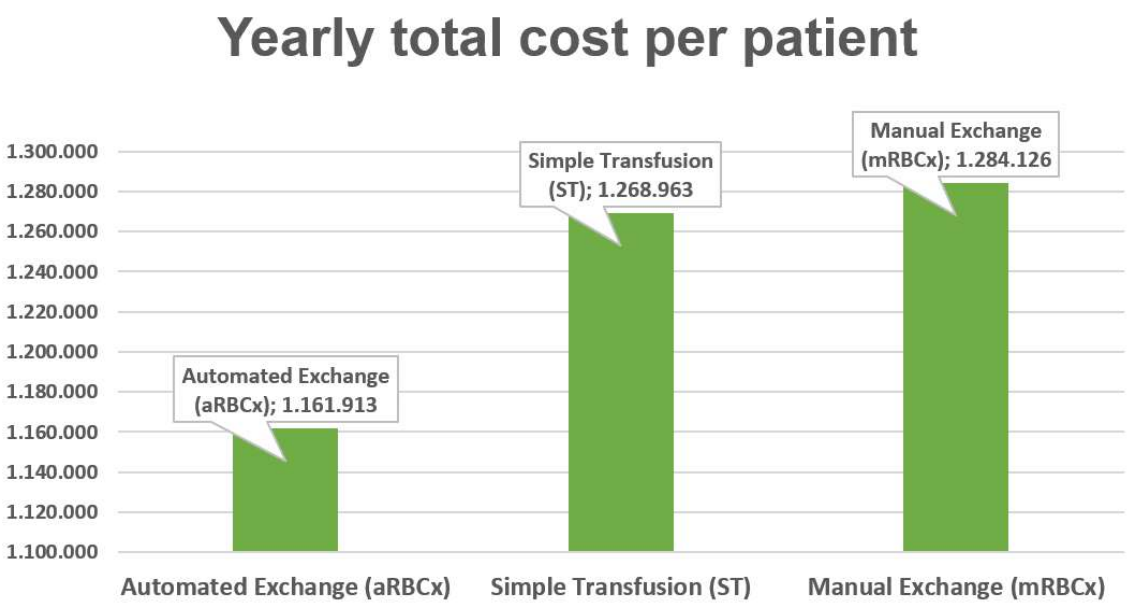

Figure 6. Clustered column chart of the yearly total cost per patient per transfusion type: ST, mRBCx and aRBCx.

CONCLUSIONS

With yearly total cost per patient of 1.268.963 BRL when treated with ST; 1.284.126 BRL when treated with mRBCx ; and 1.161.913 BRL when treated with aRBCx; **aRBCx is positioned as the most cost-effective option** among the three transfusion modalities for SCD patients for the Brazilian SUS.

aRBCX can promote a reduction in overall resources utilization, such as healthcare personnel, hospitalization and bed retention, as well as reducing the disease burden, the need for chelation therapy, and improving patient outcomes.

We encourage the Brazilian SUS to perform similar calculations among the three treatment modalities on a national and local level; and develop strategies to facilitate the inclusion of the most cost-effective one (aRBCx in this study) in clinical protocols and therapeutic guidelines (PCDT) for treating SCD and to promote it as the main transfusion modality for SCD.

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ABSTRACT

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RESULTS:
Our results reflect the costs and benefits’ differences among the three transfusion modalities for the Brazilian NHS. When considering the cost of treatment, consequence, complications, lives lost and live years lost, aRBCx is dominant over the other options. Yearly intervention cost per patient in Brazilian Reals (BRL): [ST 5672; mRBCx 10,810; aRBCx 19,519]. Yearly cost of treatment choice related in BRL: [ST 18,846.54; mRBCx 14,141.36; aRBCx 7,536.69]. Yearly cost of disease complications in BRL: [ST 178,441; mRBCx 180,667; aRBCx 159,344]. Cost of lives lost per patient in BRL per year: [ST 7,172; mRBCx 7,072; aRBCx 6,005]. Total yearly cost per patient estimated in BRL: [ST 1,268,963; mRBCx 1,284,126; aRBCx 1,161,913].

CONCLUSIONS:
With yearly total cost per patient of 1.268.963 BRL when treated with ST; 1.284.126 BRL when treated with mRBCx ; and 1.161.913 BRL when treated with aRBCx; aRBCx is positioned as the most cost-effective option among the three transfusion modalities for SCD patients for the Brazilian SUS.
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