The impact of external donor support through the U.S. President's Emergency Plan for AIDS Relief on the cost of red cell concentrate in Namibia, 2004-2011

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Background. External assistance can rapidly strengthen health programmes in developing countries, but such funding can also create sustainability challenges. From 2004-2011, the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) provided more than $ 8 million to the Blood Transfusion Service of Namibia (NAMBTS) for supplies, equipment, and staff salaries. This analysis describes the impact that support had on actual production costs and the unit prices charged for red cell concentrate (RCC) units issued to public sector hospitals.

Materials and methods. A costing system developed by NAMBTS to set public sector RCC unit prices was used to describe production costs and unit prices during the period of PEPFAR scale-up (2004-2009) and the 2 years in which PEPFAR support began to decline (2010-2011). Hypothetical production costs were estimated to illustrate differences had PEPFAR support not been available.

Results. Between 2004-2006, NAMBTS sold 22,575 RCC units to public sector facilities. During this time, RCC unit prices exceeded per unit cost-recovery targets by between 40.3% (US$ 16.75 or N$ 109.86) and 168.3% (US$ 48.72 or N$ 333.28) per year. However, revenue surpluses dwindled between 2007 and 2011, the final year of the study period, when NAMBTS sold 20,382 RCC units to public facilities but lost US$23.31 (N$ 170.43) on each unit.

Discussion. PEPFAR support allowed NAMBTS to leverage domestic cost-recovery revenue to rapidly increase blood collections and the distribution of RCC. However, external support kept production costs lower than they would have been without PEPFAR. If PEPFAR funds had not been available, RCC prices would have needed to increase by 20% per year to have met annual cost-recovery targets and funded the same level of investments as were made with PEPFAR support. Tracking the subsidising influence of external support can help blood services make strategic investments and plan for unit price increases as external funds are withdrawn.

Keywords: blood safety, Namibia, costing, PEPFAR.

Introduction

Since the 1990s, international donors including the European Union (EU), Japan, and the U.S. Government through the President's Emergency Plan for AIDS Relief (PEPFAR) have invested hundreds of millions of dollars in African blood transfusion services[1-5]. These investments have largely focused on the prevention of transmission of human immunodeficiency virus (HIV) via transfusion[6], but have expanded in some countries to provide broad-based support for operations, procurement and human resource development[2]. Several reports suggest a temporal association between these blood safety investments and improvements in the safety and availability of blood in countries receiving assistance[1,7,8]. However, in addition to supporting accelerated progress in technical indicators, there are concerns that external funds can negatively affect the sustainability of national health systems, especially in low-income countries[9]. This phenomenon has recently been examined in health sectors such as HIV treatment services[10-12].

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Over the last decade, several studies have evaluated economic aspects of blood safety projects in African and other developing countries, but most have focused on specific laboratory or blood bank costs, or on the cost-effectiveness of investments in infectious disease screening of donated blood units[13-17]. Other reports have commented on the positive and negative influences of international assistance on sub-Saharan African blood services[18]. To our knowledge, no evaluations have tracked the influence of external aid on the actual costs of producing red cell concentrate (RCC) units in sub-Saharan Africa, or on the ability of recipient blood services to sustain domestic resources during periods of increasing, and then declining, external support.

Namibia, a country of approximately 2.1 million people in southern Africa[19], was one of the first 15 countries to receive financial support from PEPFAR starting in 2004. Since then, Namibia's national HIV/AIDS response has received more than $ 650 million from PEPFAR, of which approximately $ 8.6 million was given to the Blood Transfusion Service of Namibia (NAMBTS)[20]. NAMBTS used the annual PEPFAR grants to fund personnel, equipment, consumables, and a contract with the South African National Blood Service (SANBS) to provide infectious disease screening for all blood units donated in Namibia. PEPFAR funds also supported the development of a local costing algorithm, which NAMBTS uses to set unit prices for RCC and other components sold through a national cost-recovery programme. NAMBTS also leveraged PEPFAR funds to allow domestic resources to be diverted for capital construction projects. For this study, data from the NAMBTS costing tool were used to track the evolution of RCC production costs and public-sector unit prices in Namibia between 2004 and 2011, and to estimate what those costs would have been without the annual PEPFAR contribution. The relationship between reductions in PEPFAR support to NAMBTS and the sustainability of services in the context of increased unit prices, as well as risks to blood availability resulting from consumers' inability to pay, are also discussed.

Materials and methods

NAMBTS maintains a financial database that captures information related to costs and income associated with collecting, processing, storing, and distributing blood and blood components. In 2011, 33 public and 12 private sector healthcare facilities requested blood from NAMBTS, which is the sole provider of blood in Namibia. A blood costing tool was developed in 2009 by a Namibian accounting firm (SGA Accountants and Auditors) to support the cost-recovery system on which NAMBTS, a non-profit organisation, depends for the majority of its annual revenue. The SGA blood costing system is accepted by NAMBTS's major customers (Ministry of Health and Social Service [MOHSS], private insurance firms) as the standard by which, under the National Blood Policy[21], NAMBTS sets national unit prices annually. NAMBTS negotiates annual unit prices with each customer using a cost-recovery target, known as the "production cost", generated by the SGA system. To calculate the production cost, an algorithm allocates costs to each blood component produced based on more than 120 variables related to the level of time, energy and effort required in each production process. Variables analysed by the algorithm are similar to the "direct medical and non-medical" costs recently summarised by Kacker *et al.*[22] However, because NAMBTS is not responsible for performing transfusions, the algorithm only captures cost information from activities in the "pre-transfusion" category (donation, processing, testing, storage, shipment) and from the blood bank portion of the "transfusion" cost category (testing, matching) described by Kacker *et al*. Cost variables include human resources, equipment and consumables, capital investments, logistics, promotional and educational activities, utilities, and overhead. Amortisation and other accounting adjustments are made by the NAMBTS finance department prior to data being entered into the SGA tool. Cost variables are allocated proportionally to five broad process categories: blood collection, infectious disease screening and ABO/Rh serology, component production, cold chain storage, and distribution. In each category, costs are assigned to units that will be eligible for sale. Since costs cannot be recovered from discarded components, waste units carry no value in the algorithm; all waste costs are incorporated into the prices of units that will eventually be sold.

The final cost-recovery target for each component unit (production cost) is calculated by subtracting income received by NAMBTS outside of the cost-recovery system, e.g., grants and private donations, from the total process costs associated with each component type and dividing that difference by the number of units eligible for distribution (see formula).

$$\text{Cost recovery target} = \sum \frac{(\text{process costs-other revenue})}{(\text{units eligible for distribution})}$$

Unit prices are negotiated with customers based on the unit cost-recovery target, which represents the financial "break-even" point for NAMBTS. Unit prices are therefore influenced by the total number of units eligible for sale, production costs, and the availability (or lack) of additional revenue to off-set production

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costs. Because data from each year represented actual annual costs, outputs were not further adjusted for inflation.

While NAMBTS is a not-for-profit organisation, under its charter some additional revenue may be generated annually above the "break-even" target, provided this surplus is fully reinvested in the organisation.

During the study period, NAMBTS produced whole blood and whole blood-derived platelets, plasma and RCC, as well as apheresis platelets and plasma. For this evaluation, only RCC were selected for the per-unit cost analysis as they accounted for the majority of units sold annually from 2006-2011, and because RCC production methods did not change substantially during this time period. Additionally, since units sold to the Namibian public sector (MOHSS) accounted for more than 80% of annual NAMBTS revenue each year, this analysis focused exclusively on the public sector. While not presented here, a sub-analysis by one of the co-authors (A. Bocking) confirmed that year-end surplus/deficit figures would not have changed significantly if private sector data had been included in the analysis. This is due, in part, to the fact that unit price negotiations with the public and private sectors are based on the same cost-recovery targets. While year-on-year changes in "production costs" and unit prices were only analysed for RCC, the review of annual surpluses or deficits was based on costs and revenues for all components produced by NAMBTS. Because RCC units are produced and sold within a limited time-frame (approximately 40 days), production costs and revenue data from each year were considered individually.

PEPFAR funds were provided to NAMBTS via U.S. Centers for Disease Control and Prevention (CDC) cooperative agreements. Annual CDC budgets and work plans were reviewed to identify NAMBTS activities supported by PEPFAR. The first year, 2004, was considered a baseline since PEPFAR funds were not available until August, limiting PEPFAR's impact on production costs during that year. The final year, 2011, was selected to document the impact of reduced PEPFAR funding to NAMBTS starting in 2009. The SGA blood costing system was re-run without the PEPFAR income variable to simulate the potential impact on annual cost-recovery targets with all other variables kept the same. Since Namibia has a strategic plan for increasing blood collections, improving laboratory screening, and expanding training, the simulation presumed that NAMBTS would have attempted to achieve the same blood collection and screening targets as during the study period.

This study included all RCC units from 2004-2011 for which an invoice was available. For statistical analyses, the dataset was considered a census and no sampling adjustments were required. All analyses were conducted using actual Namibian dollar budget figures, which were converted to US dollars using average annual exchange rates[23], and stratified by year. Because actual cost figures were used for each year, budgets were not adjusted for inflation; actual dollar amounts reported for each year were assumed to reflect differences due to inflation. Changes between years were calculated, as were average rates of change over multiple years. Standard deviations were calculated, where relevant. Annual blood collection data were provided by NAMBTS.

Data collection was approved by the Namibian Ministry of Health and Social Services (MOHSS) and was determined to be non-research by the U.S. Centers for Disease Control and Prevention (Atlanta, GA, USA).

Results

PEPFAR provided $ 8,656,898 in support to NAMBTS from 2004 to 2011 (annual range: $ 857,458-$ 1,500,000). On an average annual basis, NAMBTS used more than half of the annual grant for consumable supplies, equipment, and transfusion-transmitted disease testing. The proportion of the grant spent on equipment was highest from 2004 to 2009, the years during and after the construction of the new national blood centre. The next largest proportion of the annual PEPFAR grant supported personnel costs for between nine and twelve technical and administrative staff. Smaller proportions of the PEPFAR grants were spent on travel and other costs, including equipment maintenance and utilities (Table I). Approximately $ 1.3 million was disallowed for a proposed construction project during the first 2 years of the agreement; these funds were re-directed to the personnel, equipment and supply categories, and are reflected in the proportions in Table I. The construction project was ultimately financed with domestic resources.

During the study period, NAMBTS whole blood collections increased 22%, from 19,154 units in 2004, to 23,338 units in 2011. With a population of approximately two million during the study period, this level of collections corresponded to approximately 9-11 units collected per 1,000 population, a level aligned with a widely accepted target for developing countries of 10 units per 1,000 population. NAMBTS also increased RCC production from whole blood collections, from less than 50% of red cell units issued nationally in 2004, to nearly 100% in 2011. The distribution of blood components to remote regions more than 200 km from the capital, Windhoek, was also improved[24].

Namibia's national inflation rate averaged 5.6% between 2004 and 2011, rising from 4% in 2004 to 10% in 2008, before falling to approximately 5% in 2011.

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Table I - Summary of cost categories associated with the PEPFAR-funded co-operative agreement for blood safety in Namibia, 2004-2011.

Year	2004-2005	2006	2007	2008	2009	2010	2011
Budget	$ 1.899.440	$ 1.000.000	$ 1.200.000	$ 1.200.000	$ 1.500.000	$ 1.000.000	$ 857.458
Salaries & Benefits	9,6%	25,2%	23,6%	22,8%	20,4%	38,1%	31,3%
Equipment	32,2%	2,8%	5,5%	1,5%	7,3%	0,0%	0,0%
Supplies	10,3%	16,3%	28,3%	67,6%	65,5%	61,9%	68,7%
Travel	4,1%	7,2%	6,8%	2,7%	2,4%	0,0%	0,0%
Other	25,9%	3,5%	35,8%	5,6%	4,4%	0,0%	0,0%
Contractual	17,8%	45,0%	0,0%	0,0%	0,0%	0,0%	0,0%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

2004-2005 summary based on planned budget described in March 31, 2006 NAMBTS audit. NB: Of this budget, $ 629,610 (33.1%) was carried over to year 2.
2006 summary based on proposed budget submitted with NAMBTS year 2 cooperative agreement continuation application, March 3, 2006.
2007 summary based on CDC notice of award dated 9/11/2007.
2008 summary based on CDC notice of award dated 10/6/2008.
2009 summary based on proposed budget submitted to CDC on February 23, 2009.
2010 summary based on actual budget described in March 31, 2011 NAMBTS audit. There was no balance to carry-over.
2011 summary based on budget proposed in 2011 continuation application.

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"Production costs" and unit prices (2004-2011)

NAMBTS invoiced the MOHSS for 104,162 RCC units from 2004 to 2011. Annually, recoverable "production costs" ranged from US$ 41.64 (N$ 273.04) per unit in 2004, when 6,589 units of RCC were sold to the MOHSS, to US$126.95 (N$ 928.03) per unit in 2011, when 20,382 units of RCC were sold (Figure 1). Annual cost-recovery targets represented by "production costs" increased by 9% on average (SD±33.5) during the peak years of PEPFAR funding (2004-2008) but grew sharply, by 41.8% (SD±21.2), from 2009 to 2011, as PEPFAR funds declined (Figure 1). From 2004 to 2011, unit prices for RCC invoiced to the MOHSS increased by an annual average of 19.2% (SD±24.5), from US$ 58.39 (N$ 382.90) per unit in 2004 to US$103.64 (N$ 757.60) per unit in 2011.

Between 2004 and 2006, annual RCC unit prices exceeded "production costs" by an average of 113% per year, or an average of US$ 34.32 (N$ 227.59) per unit per year. However, annual revenue surpluses narrowed substantially between 2007, when RCC unit prices exceeded "production costs" by 79%, and 2011, when RCC unit prices recouped only 82% of the estimated "production costs", a loss of US$ 23.31 (N$170.43) per unit.

Impact of PEPFAR funding on NAMBTS revenues

In 2004, NAMBTS reported an annual revenue of US$1,183,423 (N$ 7,760,149) from sales of 21,088 units of blood and blood components to the public sector. Recoverable production costs (for all components) totalled US$ 1,283,507 (N$ 8,416,441) in 2004, resulting in an operating deficit of US$100,085 (N$ 656,293). From 2005 to 2010, NAMBTS reported a public sector revenue of US$ 10,389,134 (N$ 77,771,693) (annual average: US$ 1,731,522 (N$ 12,961,949)) from sales of 136,474 units of blood and blood components (annual average: 22,746). During this period, recoverable production costs totalled US$ 8,230,789 (N$ 61,838,194) (annual average: US$ 1,371,798 [N$ 10,306,366]), resulting in a total 6-year surplus of US$ 2,158,346 (N$ 15,933,499), or an average annual surplus of US$ 359,724 (N$ 2,655,583). In 2011, after 2 years during which the PEPFAR grant had been reduced by 43% (from $ 1.5 million/year to $ 857,458/year), NAMBTS reported a deficit of US$ 599,728 (N$ 4,383,979) based on a revenue of US$ 2,742,924 (N$ 20,050,611) from the sale of 25,614 units.

When annual PEPFAR grants were removed from the other revenue totals used to calculate annual "production costs", projected cost-recovery targets increased substantially. The simulation suggested that between 2008 and 2011, RCC unit prices would have needed to increase annually by an average of US$ 42.65 (N$ 336.30), or 50.5% per year in order for NAMBTS to break even financially and sustain the same level of investment in staff, equipment, training and logistics (Figure 1).

Discussion

External support from PEPFAR allowed NAMBTS to leverage revenue surpluses generated through its cost-recovery system for investments in long-term capital projects, including the construction of a new national blood centre and the purchase of land for future capital expansions in other regions of the country. These construction and real estate projects were not directly

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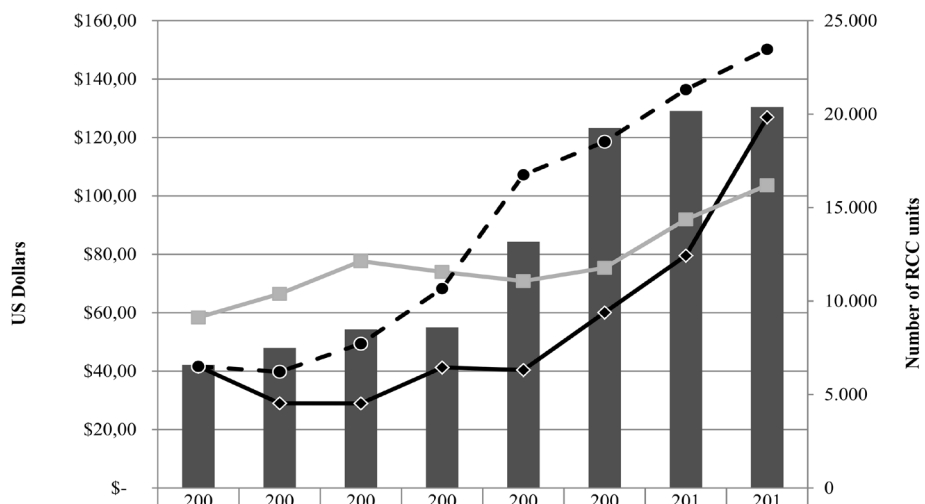
funded by PEPFAR, but were indirectly made possible by the annual grants' offsetting other routine expenses, such as personnel, the procurement of consumable supplies, infectious disease testing, and the purchase of equipment for the new blood centre. PEPFAR funds for additional vehicles also allowed NAMBTS to accelerate mobile blood collections and, as a consequence, increase RCC sales faster than may have been possible if the funds had not been available. Annual surpluses accrued during the peak years of PEPFAR also helped insulate NAMBTS temporarily from a gap in MOHSS payments in 2009-2011 when a 17.8% increase in unit prices (linked to the reduction in PEPFAR support) was not accounted for in MOHSS reimbursement budgets. Without the surpluses accrued during the peak PEPFAR years, NAMBTS risked assuming debt to cover operating costs during the several month payment delay (Personal communications, R. Wilkinson; M. Mataranyika, 2011). The MOHSS has since adjusted its annual reimbursement budget to reflect the higher unit prices. However, the sharp increase in "production costs" between 2008 and 2011, as well as future cost increases suggested by the simulation, indicate that the MOHSS should prepare for similar increases to its blood component reimbursement budget in coming years. Indeed, were deficits similar to that recorded in 2011 to continue, this analysis suggests the surplus accumulated between 2004-2010 would only be sufficient to cover those losses (and continue current operations) for approximately 3 years. PEPFAR policy planners should remain aware of the impact that reductions in funding may have on RCC unit prices, and the ripple effect these changes may have on government health budgets. Communication between all three stakeholders on issues related to operational and financial planning will be essential to avoid future revenue gaps.

Conclusion

Namibia's experience with PEPFAR is unique because of the country's robust cost-recovery system, which pre-dated the PEPFAR initiative. Unlike blood services in other countries, where PEPFAR grants supplement fixed budgets from national Ministries of Health, Namibia's public sector contributions to the NAMBTS budget are directly linked to RCC and other blood component consumption in public hospitals. The NAMBTS costing system also provided a unique mechanism to track unit prices against production costs, and to model the subsidising influence of external funding on costs by simulating the removal of the PEPFAR grant.

Like all simulation-based analyses, this evaluation is subject to several limitations. First, although the national strategic plan calls for an increase in blood collections to meet rising national demand for blood transfusions, it is unknown whether NAMBTS would have been able to increase unit prices to the projected levels to fund the level of investment seen during the peak PEPFAR years. Given other pressures on the MOHSS budget as PEPFAR's overall support to



	2004	2005	2006	2007	2008	2009	2010	2011
Total units sold per year	6.589	7.497	8.489	8.598	13.174	19.264	20.169	20.382
Actual Cost Per Unit (RCC)	$41,64	$28,99	$28,94	$41,24	$40,40	$60,08	$79,55	$126,95
Actual State Price Per Unit (RCC)	$58,39	$66,47	$77,67	$73,95	$70,83	$75,36	$91,95	$103,64
Without PEPFAR Cost Per Unit (RCC)	$41,64	$39,78	$49,38	$68,26	$107,21	$118,56	$136,40	$150,21

Figure 1 - Evolution of adult red cell concentrate (RCC) cost-recovery targets (production costs) and actual unit prices with the PEPFAR grant and a modelled estimate of potential costs without PEPFAR. Namibia, 2004-2011.

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Namibia's HIV/AIDS response declined between 2009 and 2011, the MOHSS might not have agreed to pay higher RCC unit prices, or might have rationed blood consumption in public hospitals. Simply accounting for an average national inflation rate of 6% (range: 2-10%) during the study period, it is not difficult to imagine threats to the growth of Namibia's blood supply, and to the sustainability of the NAMBTS cost-recovery system. Specifically, NAMBTS could face an unhealthy cycle in which increasing production costs and tighter MOHSS budgets could prohibit investments to expand blood collections, while a lack of growth in collections could contribute to stagnation in revenues. The costing tool used for this analysis is unique in sub-Saharan Africa and has not been externally validated. However, since the tool's output is accepted by all "customers" in Namibia, the results presented here represent an accurate portrait of the current situation. Due to the high proportion of RCC units produced and sold compared to other blood components, the historical RCC prices reported here reflect RCC's subsidizing role as NAMBTS introduced and expanded the production of specialty blood components, such as apheresis platelets (Figure 2).

Despite its limitations, the findings of this study clearly demonstrate that operating a national blood transfusion service is expensive, even in a resource-constrained setting. Prudent use of the PEPFAR-supported budget surpluses by NAMBTS allowed the service to generate sufficient revenue by increasing the number of units available for sale through the cost-recovery system. At the same time, however, the PEPFAR grants also contributed to artificially low cost-recovery targets, a situation that will need continued consideration in order to avoid future deficits. Addressing the gap between unit prices and cost-recovery targets without introducing unsustainable price shocks for the MOHSS will be a challenge for NAMBTS and the MOHSS, particularly as the Namibian government absorbs a greater proportion of HIV/AIDS, malaria and tuberculosis programme costs previously subsidised by PEPFAR and the Global Fund.

These findings are of particular importance for blood services in countries that depend on public financing and are faced with declining levels of external support. In Namibia, government funding declined from 63% of the public health sector budget in 2001/02 to 54% in 2008/09, while the proportion of the public health sector budget shouldered by PEPFAR and the Global Fund rose from 4 to 22% during the same period[25]. As PEPFAR continues to scale back in Namibia, and as the government of Namibia pursues its Abuja Declaration objective to invest 15% of its annual budget in health[26], this proportional shift will be incrementally reversed. While this review of Namibia's

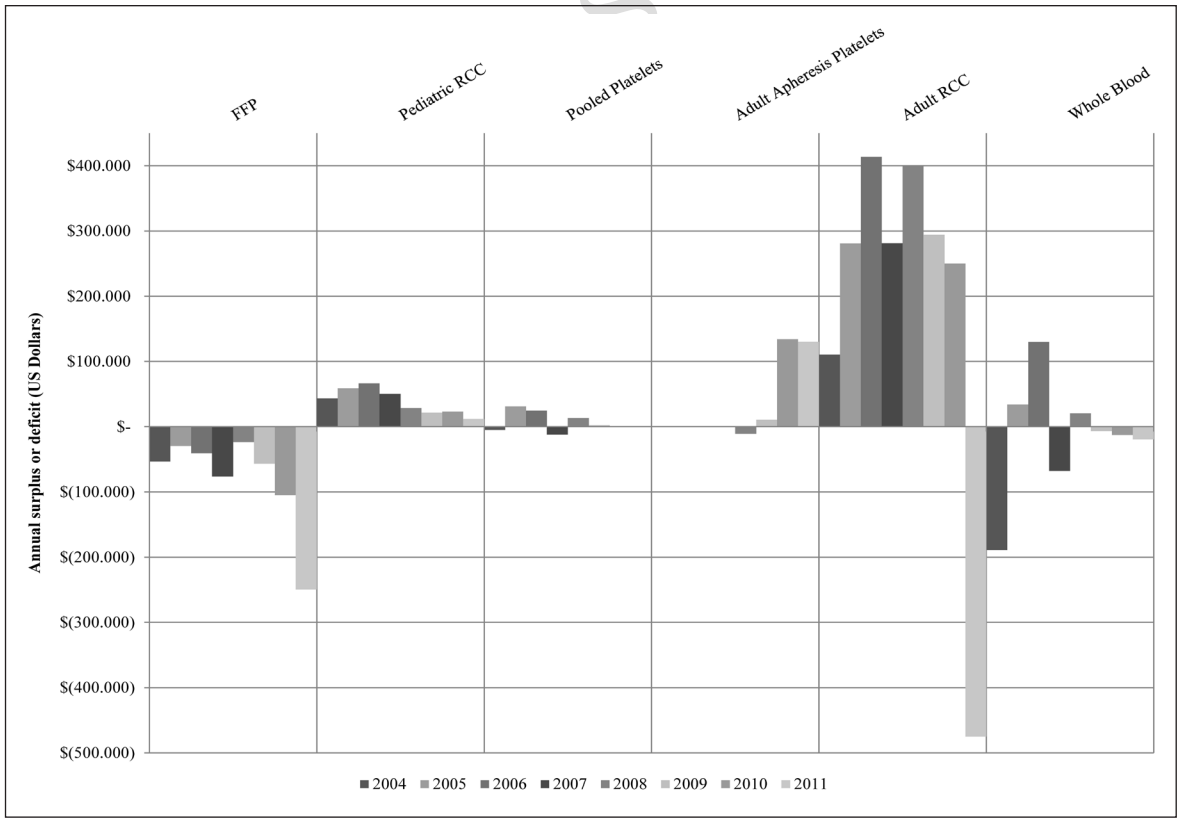

Figure 2 - Distribution of annual surpluses and deficits related to the sale of blood components in Namibia, 2004-2011. FFP: fresh frozen plasma; RCC: red cell concentrate.

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experience demonstrates that NAMBTS has the capacity to track costs and increase RCC unit prices accordingly, pressure to increase government health spending in other areas (e.g., HIV/AIDS) may limit the growth of the MOHSS blood reimbursement budget. Reduced public sector reimbursements could have important implications for the use of blood in public hospitals (e.g., rationing), changes that could adversely impact patient care and impose additional costs on the healthcare system and society.

As the number of externally-funded blood safety projects in Africa declines, international donors and recipient governments should carefully evaluate the impact of reduced donor funding on RCC unit costs and consider alternatives to public financing, including an expanded role for private insurance companies as contributors to national blood services' revenues. Lastly, although these data show that the cost of RCC produced by NAMBTS is far less than costs for similar components in industrialised countries[27], additional evaluations are needed to understand how future investments in areas such as technology and human capacity development can maximise the cost-effectiveness of blood transfusion services not only in upper-middle income economy countries such as Namibia, but in other resource-limited settings, as well.

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Disclaimer

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Authorship contributions

JPP, AB, RW, and SVB participated in study design, study supervision, data collection, and data interpretation; CSS, MJP, MM, BvF, AAM and DWL participated in data interpretation. All authors participated in writing the manuscript and approved the final content. JPP had full access to all of the data and takes responsibility for the accuracy of the data analysis.

The Authors declare no conflicts of interest.

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