Health System Costs of Rheumatic Heart Disease Care in South Africa

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Abstract

Background

Rheumatic Heart Disease (RHD) is a disease of poverty that is neglected in developing countries, including South Africa. Lack of adequate evidence regarding the cost of RHD care has hindered national and international actions to prevent RHD related deaths. The objective of this study was to estimate the cost of RHD-related health services in a tertiary hospital in the Western Cape, South Africa.

Methods

The primary data on service utilization were collected from a randomly selected sample of 100 patient medical records from the Global Rheumatic Heart Disease Registry (the REMEDY study), a registry of individuals living with RHD. Patient-level clinical data, including, prices and quantities of medications and laboratory tests, were collected from the main tertiary hospital providing RHD care. All annual costs from health system perspective were estimated in 2017 (base year) South African Rand (ZAR) using a combination of ingredients and step-down costing approaches and later converted to United States dollars (US$). Step-down costing was used to estimate provider time costs and all other facility costs such as overheads. 3% discount rate was also employed in order to allow depreciation and opportunity cost. We aggregated data to estimate the total annual costs and the average annual per-patient cost of RHD and conducted a one-way sensitivity analysis.

Results

The estimated total cost of RHD care at the tertiary hospital was US$ 2 million (in 2017 US$) for the year 2017, with surgery costs accounting for 65%. Per-patient average annual costs were US$ 3900. For the subset of costs estimated using the ingredients approach, outpatient medications, and consumables related to cardiac catheterization and heart valve surgery were the main cost drivers.

Conclusions

RHD-related healthcare consumes significant tertiary hospital resources in South Africa, with annual per-patient costs higher than many other non-communicable and infectious diseases. This analysis supports the scaling up of primary and secondary prevention programs at primary health centers in order to reduce future tertiary care costs. The study could also inform resource allocation efforts and provide cost estimates for future studies of intervention cost-effectiveness.

Background

Rheumatic heart disease (RHD) is the most common acquired cardiovascular disease among children and adolescents in low- and middle-income countries [1, 2]. It is a chronic inflammatory disease of the heart valves that result from recurrent episodes of acute rheumatic fever (ARF). RHD often leads to heart failure, stroke, and premature death, including among children and young adults [3]. A recent study

estimated about 33 million prevalent cases and 320,000 deaths from RHD globally in the year 2015 [2, 4]. African countries have some of the highest rates of RHD in the world [5].

Previous studies in higher-income regions have documented that the cost of RHD is high because most affected individuals experience a lifetime of repeat hospital admissions and expensive surgical care; the physical and psychological impact on patients and households is also significant [6]. The condition results in high levels of resource use, particularly in middle-income countries where access to advanced cardiovascular services – including heart valve surgery – is increasing [2, 7]. Even though surgery can save or prolong life, access remains low in many countries due to shortages in surgical services themselves as well as lack of early diagnosis and prompt referral [8]. Whether cardiac surgery programs are fiscally sustainable in low- and middle-income countries is also unclear [9].

Lack of information on the cost of RHD is a barrier to the equitable allocation of resources to prevent and treat the condition and assess new RHD technologies and interventions through comparative cost-effectiveness analyses [10]. A recent review found very few studies on the economics of RHD and no studies of the cost of care in the African context [8]. The objective of the present study was to estimate the cost of care for RHD from the public health system (provider) perspective at a tertiary hospital in urban South Africa. We look at outpatient costs and inpatient costs at four different levels of care – outpatient care, cardiac intensive unit (ICU) care, cardiac catheterization laboratory, and cardiac surgical theatre care – that are the major clinical areas/levels where individuals with RHD receive cardiac services (and incur costs) in the South African context.

Methods

Study Setting and Population

This cross-sectional cost analysis study was carried out in 2017 at Groote Schuur Hospital (GSH), a public tertiary level healthcare facility that serves the Western Cape Province. We focus on (a) estimating the total costs incurred at GSH in 2017 because of RHD, (b) estimating the per-patient annual cost of care using a representative sample of individuals requiring tertiary care at GSH. The RHD Pathway of Care (presented in appendix 1) is often different, and most cases are referrals from outside GSH.

Identifying clients with RHD

In this study, cost data from GSH were complemented with more detailed data on patient utilization of health services that were obtained from randomly selected 100 participants in the Global Rheumatic Heart Disease Registry (the REMEDY study), an international registry of RHD that includes cases enrolled at GSH [11].

The REMEDY study recruited 448 participants from GSH over 2012–2014. Research staff reviewed and selected new patient folders, separately documenting current patterns of disease pathology and care delivery in order to investigate the clinical epidemiology of RHD. The observational REMEDY study did not

provide any care to RHD patients; however, they captured major adverse events and instances of defaulting on medications or other aspects of care over a 24-month follow-up. We randomly sampled 100 of the 448 REMEDY participants in order to calculate parameters related to healthcare utilization.

Of note is that, subjects enrolled in REMEDY rarely utilized emergency departments (ED) because they were generally clinically stable, visiting GSH outpatient departments twice yearly on average to evaluate progression. Also, pharmacy (refill) visits are few and are much less resource-demanding compared to clinical follow-ups; often, patients collect pre-packed and dispensed medications from a third-party provider. This situation made it challenging to defining the input and outcome guides for ED and pharmacy encounters at the individual, population and system levels [26]. Consequently, we did not attempt to estimate pharmacy visit or emergency department costs outside GSH.

Costing approach

We calculated the economic cost of providing RHD care from the health system (provider) perspective. Retrospective costing was conducted using a mix of the ingredients and step-down approach by aggregating costs at different levels. All data were collected from January 2017 to December 2017. Costs were calculated in ZAR using 2017 as the base year and later converted to US$. We used a set of four data collection instruments, one for each of the major clinical units where RHD care is delivered at GSH: cardiac clinic, medical and ICU ward, cardiac catheterization laboratory, and surgical theatre.

Ingredients Costing

This approach primarily used detailed medical records and observations to measure the specific resources required for delivering RHD care. We studied utilization patterns of resources such as medications, laboratory tests, and diagnostics and consumables related to RHD care. For example, the cost of medication was estimated according to the number of medications recorded as dispensed for each of the 100 REMEDY participants then multiplied by the cost per dosage/injection. We also reviewed REMEDY and other hospital medical records to establish utilization rates for specific services, and semi-structured interviews with clinical experts in RHD care were also conducted. The cost-share of cardiac medical and ICU care on RHD was calculated using the number of inpatient bed-days at GSH; i.e. by multiplying the number of admissions with the average length of stay. The average length of stay of individuals with RHD in the cardiac wards was 4.7 days per admission according to the most recent annual report.

We obtained pricelists for commodities from the Western Cape Department of Health (Wendy Braynt, 2018 -personal communication). As per treatment guidelines and the data obtained from medical records, direct medical costs were calculated using the accounting identity; i.e., costs incurred are the product of prices and quantities of goods and services consumed.

Step-down Costing

Step-down costing approach is commonly used to estimate costs that are long-term but not directly related to the patient utilization, including costs borne by support departments in health facilities [12].

Capital costs (e.g., medical building, equipment and furniture) and recurrent indirect costs (e.g., overhead costs incurred by GSH, electricity, water, cleaning, security) of proving RHD care were costed using the step-down approach.

Capital item costs and useful lifetimes were obtained from the hospital procurement department. Original costs obtained were also inflated to 2017 levels using the consumer price index [12]. Equipment and furniture item costs were apportioned to RHD care according to the share of RHD patients using the items. Building costs were estimated using a square meter of space apportioned for RHD care. Costs were calculated by multiplying by the building replacement value per square meter (US$ 3200), which was obtained from the building and engineering company-approved tender estimate for GSH [13]. Recurrent cost data were obtained from the finance department of GSH for the 2016/2017 financial year.

As recommended by the World Health Organization (WHO), capital items were discounted and annualized using a discount factor of 3%, reflecting depreciation and the opportunity cost of purchasing the capital items [14]. An estimated lifetime of 30 years for buildings and ten years for equipment and furniture were used. Sensitivity analyses were conducted using 0%, 5% and 10% (which is a government bond rate in South Africa) discount rates to verify the robustness of the results [15].

Costs were categorized into overheads (i.e.., not directly associated with caring) and final service centers (i.e., used in care) [14, 16]. Overhead costs comprise the cost of general support services departments that are important for the facility to operate [12, 14]. These include utilities (i.e. electricity, water), non-clinical personnel (i.e. cleaning, security) as well as stores that provide non-patient specific services [12, 14]. Overhead costs were estimated by assessing the overhead expenditures, assuming that all patients utilized equal amount of overhead costs per unit time when they visit GSH [17].

The calculation for overhead costs per visit was the annual overhead expenditure divided by the annual number of patient visits. This approach was used for both outpatient and inpatient departments of GSH because cost centre accounting system does not exist in the hospital. Overhead expenditures were allocated directly to outpatients and inpatients departments using an allocation factor based on the patient day equivalent (PDE) concept [17]. PDE is estimated as:

$$\text{PDE}_{outpatients} = (annual\ inpatient\ days) \times \frac{1}{weighting\ factor}) + (annual\ outpatient\ visits)$$

$$\text{PDE}_{inpatients} = (annual\ inpatient\ days) + (annual\ outpatient\ visits \times weighting\ factor)$$

The local practice at the University of Cape Town is to employ the (empirically-based) rule of thumb that an outpatient visit costs one-third (1/3) of an inpatient day, and this is used as a weighing factor [17]. Overhead costs per outpatient visit and inpatient day at GSH are thus expressed as:

$$\text{Overhead cost per outpatient visit} = \frac{\text{annual overhead expenditure}}{PDE_{outpatients}}$$

$$\text{Overhead cost per inpatient day} = \frac{\text{annual overhead expenditure}}{PDE_{inpatients}}$$

Costs of different centers within GSH that render services to the entire hospital (i.e., intermediate costs) were incorporated in overhead costing; these included the pharmacy and laboratory departments [16]. These intermediate and overhead costs were later added to the final cost department in a sequential manner. Recurrent and capital costs were also allocated to the four clinical units directly according to their actual resource utilization. For instance, estimates of square meters of space used directly for care were used to distribute the building costs to the four units where RHD care is provided. Incurred recurrent and capital costs were distributed according to the clinical unit using allocation bases and resource usage. The number of individuals with RHD as a percentage of the total number of patients served in each clinical unit was used to calculate a utilization factor reflecting the share of costs allocable to RHD.

There was no financial cost incurred by GSH for training nurses or other staff personnel specific to RHD; however, lectures were given by senior registrars to nursing staff every Tuesday; nurses also had an opportunity to participate in catheterization procedures to teach them about post-procedure care. We excluded the economic cost component of these lectures.

Personnel Costing

Statistics regarding time allocation and time spent by different personnel providing care or consulting patients with specific diagnoses like RHD are not available at GSH. We obtained information from key clinical/hospital informants and ward operational managers through unstructured interviews and review of staff weekly duty timesheets. Eight non-participatory observations were conducted to understand patient management and staff time allocation and to identify and examined costs involved.

Total annual salary grades were obtained from the most recent GSH financial records and divided to the number of productive minutes. RHD specific personnel costs were calculated depending on the average amount of time each staff members spent on patients which were established by non-participatory observations. The limitation of this strategy is that responses could not be authenticated through time-motion studies; hence it might over- or underestimate the share of time spent on providing RHD related care.

Data Analysis

Study data were entered into Microsoft Excel for quality evaluation. This Excel costing tool is provided as a supplementary appendix file. STATA 14 was also used for the analysis of REMEDY data (utilization and patient demographic characteristics) (Statacorp, 2015).

Total cost was calculated by adding the ingredients and step-down cost estimates, while the total cost per admission was estimated by multiplying the average cost per inpatient day by the average length of

stay. The annual cost of care per-patient at each of the four clinical units was also calculated as the product of the unit cost (per encounter) times the annual utilization rate. The overall annual cost of care per-patient was calculated as the sum of annual costs at each of the four clinical units. For comparison, the total cost of providing RHD care at GSH in 2017 was extracted from the spreadsheets as the aggregate costs at each of the four clinical units (i.e., the costs required to deliver care for all individuals with RHD, including but not limited to the 100 REMEDY participants).

In order to assess the impact that changes in assumptions or parameters would have on final cost estimates; one-way deterministic sensitivity analyses were performed. The following cost model inputs were varied: (a) discount rate of 0%, 5% and 10% on capital costs [18, 19]; and (b) utilization rates of the four clinical units were varied from base values to lower and upper 95% confidence interval estimates (per the REMEDY database) to examine their effect on average annual per-patient costs [13].

Ethics approval

Ethics approval was obtained from the Human Research Ethics Committee of the University of Cape Town (UCT) (Ref: 436/2017) as well as the Western Cape Department of Health prior to commencement of the study. During the medical records review, privacy of patients was maintained, and no identifying information such as patient participants' names and identity numbers were collected.

Results

Baseline characteristics of the study sample

The demographics characteristics of the REMEDY study participants are provided in Table 1. The majority of the participants were female (67%), with the current age of participants ranging 24–81 years. Participants were predominately from low-income backgrounds, and most were unemployed. Forty-eight percent had valve surgery at some point in their lifetime, ranging 1980–2016.

Table 1
Demographic characteristics of 100 individuals with
RHD whose medical records were used for this study

Characteristic	Estimate
Mean age	48 years
Female sex	67%
Employment history	Employed 17%
	Self-employed 1%
	Unemployed 83%
Educational attainment	No formal education 2%
	Primary level 3%
	Secondary level 81%
	Tertiary level 4%

The REMEDY database provided the number of visits and admissions for the 100 patients that attended cardiac care at GSH. Utilization data were collected over two consecutive years to capture longer-term rates in clinically stable patients who only attend outpatient clinics (i.e., less frequently); these parameters are provided in Table 2.

Table 2
Average annual utilization rates for RHD care at four clinical units at GSH

Clinical unit	Outpatient clinic	Medical and intensive care unit (ICU)	Cath lab	Surgery/ theatre
Per-patient utilisation rate per year (95% confidence interval)	2.9 (2.0–3.9)	0.31 (0.11–0.50)	0.19 (0.068–0.31)	0.22 (0.043–0.39)

The unit cost of RHD services by clinical unit

Summaries of average annual per-patient costs for the four different clinical units (outpatient, cardiac ICU and ward, cardiac catheterization laboratory, and surgical theatre) are provided in Table 3, Table 4, Table 5 and Table 6, respectively. On a per-unit basis, the cardiac medical and ICU costs comprised a smaller proportion of RHD costs than did the cardiac catheterization laboratory and surgical theatre costs. Among cost components estimated using the ingredients approach, medications and staff costs were the drivers of total costs of outpatient visits, while blood transfusions and staff costs in inpatient medical and ICU care were the highest. Consumables costs were the drivers in the cardiac catheterization lab and surgical theatre.

Table 3
Outpatient total and unit costs

Cost component	Annual total cost to GSH in 2017 (US$)	Unit cost per encounter in 2017 (US$)
Costs obtained through step-down approach		
Personnel	$ 170 000	$ 55
Overheads	$ 20 000	$ 5.4
Maintenance	$ 2300	$ 1.7
Consumables	$ 8000	$ 2.3
Building	$ 25 000	$ 6.6
Equipment & furniture	$ 11 000	$ 2.9
Step-down sub-total	$ 240 000	$ 76
Costs obtained through ingredients approach		
Medications	$ 160 000	$ 240
Laboratory tests	$ 23 700	$ 35
Ingredients sub-total	$ 170 000	$ 250
Total cost		
Sum of sub-totals	$ 410 000	$ 320
Note: totals may differ slightly from individual rows due to rounding.		

Table 4
Cost of cardiac medical and intensive care unit care

Cost component	Annual total cost to GSH in 2017 (US$)	Unit cost per encounter in 2017 (US$)
Costs obtained through step-down approach		
Personnel	$ 93 000	$ 50
Overheads	$ 31 300	$ 17
Maintenance	$ 3700	$ 2.0
Consumables	$ 23 400	$ 13
Building	$ 36 000	$ 20
Equipment & furniture	$ 3000	$ 7.2
Step-down sub-total	$ 190 000	$ 110
Costs obtained through ingredients approach		
Medications	$ 9700	$ 32
Blood transfusions	$ 14 000	$ 45
Laboratory tests	$ 26 000	$ 80
Ingredients sub-total	$ 49 000	$ 160
Total cost		
Sum of sub-totals	$ 240 000	$ 270
Note: totals may differ slightly from individual rows due to rounding.		

Table 5
Cost of catheterization laboratory care

Cost component	Annual total cost to GSH in 2017 (US$)	Unit cost per encounter in 2017 (US$)
Costs obtained through step-down approach		
Personnel	$ 91 000	$ 290
Maintenance	$ 3100	$ 10
Consumables	$ 310 000	$ 970
Building	$ 30 000	$ 100
Equipment & furniture	$ 22 000	$ 430
Step-down sub-total	$ 450 300	$ 1800
Costs obtained through ingredients approach		
Medications	$ 39 000	$ 130
Ingredients sub-total	$ 40 000	$ 130
Total cost		
Sum of sub-totals	$ 490 000	$ 1900
Note: totals may differ slightly from individual rows due to rounding.		

Table 6
Cost of cardiac surgical theatre care

Cost component	Annual total cost to GSH in 2017 (US$)	Unit cost per encounter in 2017 (US$)
Costs obtained through step-down approach		
Personnel	$ 210 000	$ 2300
Maintenance	$ 4600	$ 50
Consumables: general	$ 62 000	$ 680
Consumables: perfusion	$ 250 000	$ 2800
Consumables: anaesthesia	$ 19 000	$ 200
Consumables: prosthetic valves	$ 91 000	$ 1000
Building	$ 46 000	$ 500
Equipment & furniture	$ 79 000	$ 3100
Step-down sub-total	$ 750 100	$ 11 000
Costs obtained through ingredients approach		
Medications	$ 45 000	$ 800
Ingredients sub-total	$ 45 000	$ 800
Total cost		
Sum of sub-totals	$ 800 000	$ 12 000
Note: totals may differ slightly from individual rows due to rounding.		

The cost of routine medications was the major cost driver in outpatient clinic care (74%) followed by staff time (17% of the cost). In the catheterization lab and surgical theater, consumables (such as prosthetic valves and specialized catheters) were the major drivers (51% and 44%, respectively).

In 2016 the cardiac surgery theatre at GSH performed 322 valve replacements, 56 of which were RHD-related. The most common valve replacement types were aortic (46%), mitral (41%), and mixed aortic and mitral (13%).

Aggregate cost of RHD care

As seen in Table 7, RHD care cost GSH an estimated US$ 2 million in 2017. The average cost per patient-year, based on utilization data from the REMEDY study, was an estimated US$ 3900 with (65%) of the total cost being driven by surgical theatre cost. In GSH, Forty-eight percent of the participant sample had valve surgery at some point in their lifetime, ranging 1980 to 2016. Consumables related to cardiac

catheterization and heart valve surgery were the main cost drivers. Outpatient care cost also accounts for a quarter of the total annual RHD care burden with medications (US$239) and personnel time (US$55) being the highest respectively.

Table 7
Summary costs: Aggregate costs to GSH in 2017 and estimated annual costs per-patient

Clinical unit	Aggregate cost to GSH in 2017 (US$)	% share of aggregate total cost	Estimated per-patient annual cost (US$)	% share of per-patient annual cost
Outpatient clinic	$ 400 000	21%	$ 930	25%
Cardiac medical intensive care unit and ward	$ 240 000	13%	$ 82	2.1%
Cardiac catheterisation lab	$ 490 000	26%	$ 360	9.4%
Surgical theatre	$ 800 000	41%	$ 2 500	65%
Total	**$ 1 900 000**		**$ 3 900**	
Note: percentages and sums may differ from totals due to rounding.				

Sensitivity analyses

Figure 1 demonstrates the effects that varying utilization rates at each of the four clinical units had on overall annual average per-patient costs. The costs were relatively less sensitive to variations in the discount rate (Fig. 2). In both sets of analyses, the influence of the parameters was largest on surgical theatre costs, since this was the most expensive clinical unit.

Discussion

This cost analysis sought to estimate, from the provider perspective, the annual cost of RHD care in a tertiary centre in the Western Cape Province of South Africa. RHD was estimated to cost GSH about US$ 1.9 million in the year 2017. These costs represent 11.2% of the total budget for GSH in the year 2017. Triangulating these estimates with data from the REMEDY registry, RHD was estimated to cost US$ 3900 per patient per year in total, with most of the total cost being driven by surgical theatre and cardiac catheterization laboratory costs. These costs are much higher than the annual cost of the facility-level care delivery of HIV/AIDS, drug sensitive tuberculosis, and hypertension, which have been estimated at around US$ 660 (in 2016) [20], US$ 250 (in 2015) [21], and US$ 260 (in 2016) [22] per year, respectively.

Not only has managing RHD cost more on a per-patient basis than all three of these conditions combined, but it has also been more neglected in national health policy discussions [4].

To the best of our knowledge, there have been no previous costing studies on RHD in Africa and, only one prior costing study in a low- and middle-income country setting. Terreri et al., looking at RHD in Brazil, quantified per-patient direct costs of RHD and rheumatic fever from the provider perspective using the ingredients approach [1]. Even after adjusting to a common currency and year, the cost estimates in this study are higher than in the Brazilian study, probably due to advances in care (i.e. new technologies) and to the fact that health sector prices tend to rise faster than inflation. In addition, the present study took a more detailed look at surgical care, the most expensive aspect of RHD care.

This study assessed the cost of RHD to the public sector. It did not include ambulatory costs or admission costs from the private sector. It also did not look at patient costs, including so-called "direct non-medical costs" like transport and food, which – from a societal perspective – are a significant share of healthcare costs in South Africa [17]. However, the direct medical costs were still substantial, and from a societal perspective, the cost of surgical care from the provider perspective is probably the most significant single driver of costs.

It should be noted that, amongst the "direct" costs estimated using the ingredients approach, the main cost contributors to outpatient RHD care were monthly medications followed by personnel cost, while the cost of laboratory tests, personnel and blood transfusions were major drivers for inpatient medical and ICU ward costs. These findings are similar to a study from Australia in which two-thirds of the cost of ICU care in tertiary hospitals was related to personnel [23]. Rechner and Lipman (2005) predicted that consumables expenditure (in general) is likely to increase in the future in light of new innovations and therapies. Along these lines, the cardiac catheterization lab and surgical theatre consumables were found to be major drivers of cost in this study. One implication of this study is that research on developing cheaper, locally made prosthetic valves and catheters should be supported, and measures should be taken to support the production and export of such products to other African countries [24].

This study can also be viewed as an analysis of the economic consequences of inadequate prevention of rheumatic fever and RHD. RHD can be entirely prevented by addressing bacterial sore throat in children using primary health centre-based approaches. When this prevention window is missed, rheumatic fever develops and can lead to heart valve damage, which can require one or more surgeries over the lifetime of affected individuals. Several programs in Latin America and the Caribbean demonstrated that healthcare costs from RHD declined by more than 90% when comprehensive prevention efforts were undertaken [25]. However, barriers such as poor access to primary care, shortage of skilled staff and poor public awareness about diagnosis and treatment of sore throat hindered wide adoption of primary prevention of the disease. The present study provides crucial evidence for the Western Cape Department of Health, and the National Department of Health to scale up RHD prevention efforts in South Africa.

Our study had a number of important limitations. First, it was a hospital-based cost analysis, with the usual limitations of such a study design. One hundred patient records were reviewed; however, some

details were missing, while those with severe disease were often presented with little detail. Nevertheless, considerable effort was taken to produce accurate and relevant estimates. Second, medication records did not disaggregate drugs related to RHD from drugs with other indications, potentially leading to over-estimates of RHD-specific medication costs. Third, out of the 100-participant sample, only 88 individuals were consistently engaged in RHD care in GSH. This finding raises the question of whether they were receiving care elsewhere. As noted previously, for practical reasons, we were unable to gather pharmacy dispensing or emergency department costs. In total, these factors might lead to an under-estimate of per-patient costs and GSH costs. Finally, the step-down approach is not ideal for estimating some costs such as diagnostics (echocardiography, etc.) and pharmacy costs; better data would allow for more precise estimates of these costs using an ingredients approach. Notably, the cost of pharmacy services is likely to be higher at GSH than at health facilities in the community where most individuals with RHD receive the majority of their monthly prescriptions. Overall, our estimates of average annual per-patient care costs are probably higher compared to what they would have been if referring hospitals and clinics had been sampled.

Conclusion

In summary, we found that RHD results in considerable costs to tertiary facilities in South Africa, a middle-income country with a high burden of disease and relatively good access to advanced cardiovascular care. Per-patient costs are much higher than other essential health conditions like HIV/AIDS, tuberculosis, and hypertension. The high cost of treating RHD underscores the urgency of scaling up rheumatic fever prevention efforts in order to eliminate new cases of RHD eventually. Our study can serve as an input to future economic evaluations focused on RHD programs and interventions in South Africa. We developed a costing framework and data collection tool (presented in the appendix 2) that can be expanded to other aspects of RHD prevention and care as well as replicated in other African settings. The systematic and widespread collection of data on the cost of RHD will be a crucial component of raising awareness on the importance of the condition in Africa and of making a case for investing in RHD prevention.

Abbreviations

ARF- Acute Rheumatic Fever

GSH- Groote Schuur Hospital

ICU- Intensive Care Unit

RHD- Rheumatic Heart Disease

STATA- Statistics and Data Software Package

US$- United States Dollar

WHO- World Health Organisation

ZAR- South African Rand

Declarations

Acknowledgements

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not Applicable.

Funding

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Author Contributions

Study design: OA, DW. Data collection: AH. Data analysis: AH. Data interpretation: LZ, OA, DW. Wrote the first draft: AH. All authors critically reviewed the draft manuscript and revised it for important intellectual content.

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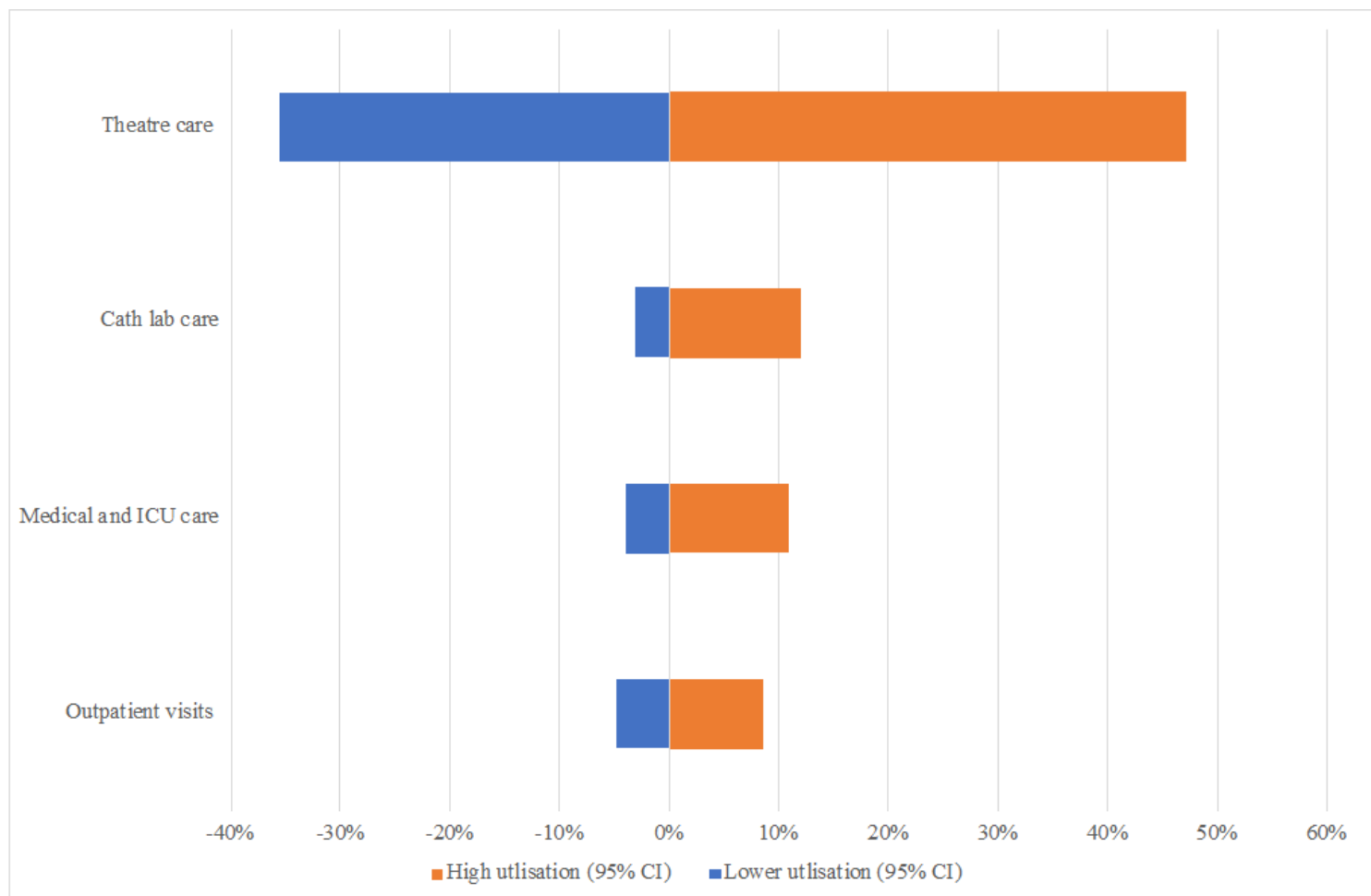
Figures

Figure 1

Sensitivity analysis: variation in utilization rates and their effect in annual per-patient cost of RHD care
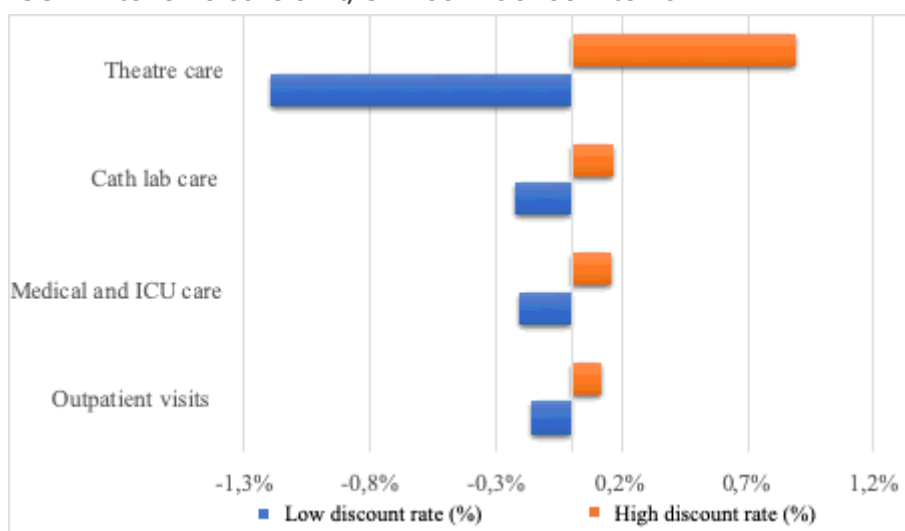ICU = intensive care unit; CI = confidence interval

Figure 2

Sensitivity analysis: variations in discount rates and their effect on annual cost of RHD care per patient

Supplementary Files

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- Appendix1.docx
- Appendix2.xlsx