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Comparative cost of ART and conventional treatment within a dental school clinic

Mickenautsch, S.; Munshi, I.; Grossman, E. S.

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studies on these and other skin barrier creams and their effects on the permeability of human skin in the presence of other deleterious compounds are therefore warranted.

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S Mickenautsch, I Munshi, ES Grossman

ORIGINAL RESEARCH PAPERS

Comparative cost of ART and conventional treatment within a dental school clinic

Keywords: Cost, ART, treatment, clinic

SUMMARY

Background: The changing oral health needs in South Africa require that both the teaching and clinical techniques of atraumatic restorative treatment (ART) form a part of the restorative undergraduate curriculum.

Objective: This study was undertaken to establish and compare the estimated costing of an amalgam, composite resin and ART restoration within the Board of Health Funders (BHF) recommended scale of benefits at the School of Oral Health Sciences Oral and Dental Hospital, University of the Witwatersrand (SOHS).

Methods: Fixed and variable costs were calculated by pricing items and equipment used in each procedure. The output values were established according to the recommended scale of benefits (BHF, 1999). This enabled the calculation of contribution margins and net income for each of the three restorations.

Results: The annual capital cost for the ART approach is approximately 50% of the other two options (e.g. per multiple surface restoration ART= R1.58; amalgam and composite resin restorative procedures: R3.12 and R3.10 respectively), despite the fact that ART restorations are rendered in a modern dental setting.

Conclusions: Our study shows that implementation of the ART approach within the clinic setting of the SOHS can be accomplished without additional cost. Furthermore ART can be performed as an economically viable alternative to conventional treatment procedures within the clinic setting. The study represents a first step towards determining the cost efficiency of implementing ART as a pragmatic and cost-effective restorative option within the SOHS, University of the Witwatersrand.

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S Mickenautsch, BDS*

I Munshi, MDent**

ES Grossman, PhD***

Dentist Supervisor, Division of Public Oral Health, Senior Specialist, Division of Restorative Dentistry** and Specialist Scientist, Dental Research Institute MRC/Wits***, School of Oral Health Sciences, Faculty of Health Sciences, University of the Witwatersrand*

Corresponding author: Dr ES Grossman, Dental Research Institute. Private Bag 3, WITS 2050, South Africa. Tel: + 27 11 717-2137, fax: + 27 11 717-2121, e-mail: ***078esg@chiron.wits.ac.za***

Introduction

Atraumatic restorative treatment (ART) has been successfully used as a tooth restoration approach in rural areas where electricity is absent, treatment facilities are non-existent or where funds do not allow conventional dentistry.[1] ART is currently being used in the peri-urban region of Johannesburg via a mobile dental unit[2] and within the public oral health services of Gauteng, North West and KwaZulu-Natal provinces. While ART may be regarded by the developed world as a palliative option exclusively for developing world

populations there is growing interest in the use of ART as an alternative method of treating patients where restorative care is difficult or impossible to provide.[3] These are patients with contraindications for local anaesthesia, housebound or institutionalised persons, fearful children, those in urgent need of dental care whose health situation contraindicates dental treatment. ART is also promoted as an adjunct to conventional dental care within the clinic setting. This is in cases of early childhood caries in toddlers or as a means of introducing a child to the restorative experience.[3] The current emphasis in South Africa on the primary health care approach[4] requires that ART be included in the restorative undergraduate curriculum. The initiation of the post-BDS community service programme in 2000 by the Department of Health in communities deprived of oral health care has brought further urgency to the teaching and implementation of the ART approach. Finally, the financial constraints under which oral health services in South Africa operate make it imperative to critically evaluate the ART approach as an economic alternative in special cases to conventional treatment procedures within the clinic setting.

This study was undertaken to establish and compare the estimated costing of an amalgam, composite resin and ART restoration within the costing framework of the School of Oral Health Sciences (SOHS), University of the Witwatersrand as a first step towards determining the cost-efficiency of implementing ART as a pragmatic and economic restorative option within the Division of Restorative Dentistry.

Method

The model used for this comparative cost analysis of restoring a single and a multiple surface cavity using amalgam, composite resin and ART was based on a study which evaluated a public services mobile dental surgery.[5] The following components were considered and defined[5] as follows. **Capital costs:** all equipment and instrumentation, linked to depreciation, used in each restorative procedure. **Variable costs:** consumables used in each procedure. **Fixed costs:** according to the model, fixed costs are computed as capital cost as well as the salary equivalent for time spent on the procedure. In this study we excluded a dentist's salary from our calculations as the services at the SOHS are rendered by unpaid students. Thus fixed costs are calculated using capital costs only. **Output value:** the benefit value set by the Board of Health Funders (BHF), formerly the Representative Association of Medical Schemes, was used to represent the total income. **Contribution margin:** the total income less the variable cost. **Net income:** the contribution margin less fixed cost.

All items used in the restoration procedures were listed and prices

Table I A. **Capital cost of one amalgam restoration**

N	Item (all manufactured in year 2000)	Qty	Estimated depreciation (in years)	Purchase price in Rand	Capital per year in Rand
Single surface					
01.	Fast handpiece	1	5	2 500.00	500.00
02.	Slow handpiece	1	5	3 000.00	600.00
03.	Mixing spatula	1	5	150.00	30.00
04.	Amalgamator	1	5	6 000.00	1 200.00
05.	Amalgam rest dispenser	1	5	150.00	30.00
06.	Dappen dish	1	5	200.00	40.00
07.	Syringe	1	5	200.00	40.00
08.	Diamond bur	1	2	12.00	6.00
09.	Steel bur	1	2	12.50	6.25
10.	Amalgam applicator	1	5	150.00	30.00
11.	Plugger	1	5	150.00	30.00
12.	Carver	1	5	150.00	30.00
13.	Dental chair	1	5	28 750.00	5 750.00
14.	Suction unit	1	5	10 100.00	2 020.00
15.	Dental unit	1	5	15 000.00	3 000.00
16.	Autoclave	1	5	14 500.00	2 900.00
17.	Mouth mirror	1	5	150.00	30.00
18.	Dental probe	1	5	150.00	30.00
20.	Dental tweezers	1	5	150.00	30.00
	Total per annum				16 302.25
	Total per month				1 358.52
	Total per day				67.93
	Total per hour				8.49
	Total per minute				0.14
	Total per restoration (22 min)				3.11
Multiple surface					
10.	Matrix retainer	1	5	150.00	30.00
	Total per annum				16 332.25
	Total per month				1 361.02
	Total per day				68.05
	Total per hour				8.51
	Total per minute				0.14
	Total per restoration (22 min)				3.12

1 month = 20 working days; 1 working day = 8 hours.

Table I B. Variable costs of one amalgam restoration

N	Item	Quantity needed	Quantity per pack	Price per pack in Rand	Price per quantity needed in Rand
Single surface					
01.	Amalgam caps.	1	100	200.00	2.00
02.	Articulating paper	1 sheet	100	150.00	1.50
03.	Cotton wool rolls	4	100	150.00	6.00
04.	Gauze	2 pads	100	25.00	0.50
05.	Lining cement	1	100	300.00	3.00
06.	Local anaesthetic cart	1	100	250.00	2.50
07.	Injection needle	1	100	50.00	0.50
08.	Mouth mask	1	100	60.00	0.60
09.	Gloves	1 pair	50 pairs	30.00	0.60
10.	Hibiscrub (hand disinfectant)	5 ml	500 ml	40.00	0.50
11.	Ultra swipes (surface disinf.)	1 wipe	160 wipes	165.00	1.03
	Total per restoration				18.73
Multiple surface					
3.	Matrix band	1	12	20.00	1.67
4.	Wedges	2	100	65.00	0.65
	Total per restoration				21.05

Table I C. Income statement: for 1 × amalgam restoration (SOHS)

Single surface			
1. Output value	R 77.00		
2. Variable cost	R 18.73		
3. Contribution margin	R 58.27		
4. Fixed costs	R 3.11		
4.1. Salary	R 0.00		
4.2. Capital cost	R 3.11		
5. Net income	R 55.16	—	*71.6%
Multiple surface			
1. Output value	R 96.20		
2. Variable cost	R 21.05		
3. Contribution margin	R 75.15		
4. Fixed costs	R 3.12		
4.1. Salary	R 0.00		
4.2. Capital cost	R 3.12		
5. Net income	R 72.03	—	*74.8%

* Net income as a percentage of output value.

obtained from the price lists of the Central Stores, SOHS, University of the Witwatersrand; Milners (PO Box 30721, Kyalami 1684); The Dental Warehouse (Private Bag X1, Highlands North 2037) and Adcock-Ingram (Private Bag 69, Bryanston 2021). Commercial prices were those in force on
1 March 2000. For Central Stores the average prices paid over a period of 2 years was used. The price of the glass ionomer used in Table IIIB is that for Ketac Molar Liquid+Powder (handmix) (ESPE, Dental Medizin, Germany supplied by The Dental Warehouse). Prices and volumes of material were resolved to calculate the cost of the consumable per restoration. The costs of white coats, water and electricity supply were excluded. While it is known that less water and electricity are used during an ART procedure the difficulties in establishing the exact amount of water or current units actuated per restoration make costing for these unfeasible. The depreciation of dental equipment was according to write-off periods laid down by the South African Revenue Services[6] with an assumed year of manufacture of 2000 in all cases.

The following BHF codes were used for each restoration type and the costs attached to each incorporated within the estimate. **Amalgam restoration:** Output value: single surface restoration: BHF 1999 code 8341; two surface restoration: BHF 1999 code 8342. **Composite resin restoration:** Output value: single surface posterior restoration: BHF 1999 code 8367; two surface posterior restoration: BHF 1999 code 8368. **ART restoration:** Up to the present there has been no BHF code assigned for the provision of ART by the Board of Health Funders. However international research has shown that the survival rates of ART restorations are comparable with amalgam under similar field conditions.[7] Therefore the BHF values for amalgam were used in order to set the output values for ART.

Results

Tables I A, B and C, respectively, list the charges attached to the capital costs, variable costs and income statement for an amalgam restoration. Composite resin and ART restoration charges are similarly shown in Tables II A-C and Tables III A-C, respectively. The results show a slight difference between the annual capital cost for dental equipment used for amalgam and composite restorations. This adds to R16 202.25 for single surface composite resin restoration and R16 302.25 for a single surface amalgam. Multiple surface restorations are marginally more costly at R16 232.25 and R16 332.25 for each material respectively. In marked contrast, annual capital costs for dental equipment used for ART restorations (R8 950.00 for single surface and R8 980.00 for multiple surface) are about 50% cheaper than for conventional restorative procedures. This is against the background of ART procedures rendered in a modern dental clinic. The lower annual capital costs are due to the inexpensive hand instruments used in the approach and the absence of costly items such as hand pieces, suction unit, amalgamator and curing light. The total capital costs per restoration similarly show that by comparison a single surface ART restoration costs 50% less at R1.58 than amalgam and composite resin restoration (R3.11 and R3.09 respectively).

Variable costs of R33.79 for a multiple surface composite resin restoration make this the most expensive treatment in this study. A multiple surface amalgam restoration is costed at R21.05 with ART being R19.60. The restorative material itself is the main determinant of size of the variable cost, amalgam costing R2.00, composite resin at R5.00 and the glass ionomer cement for ART being R6.34 per single surface. The fewer and cheaper items used in the ART approach counter the more expensive glass ionomer cement (Tables I-IIIB).

We assumed the output value for ART to be the same as amalgam restorations according to BHF recommendations. For a single surface this is R77.00 and multiple surface is R96.20. A composite resin restoration is set at R91.00 and R112.00 respectively. Fixed costs for using each of the restorative materials are virtually identical for single and multiple surface restorations. The addition of variable costs to the costing structure produced a net income for a single surface ART restoration of R58.14 (75.5 % of output value); R55.16 (71.6 %) for an amalgam restoration and R56.44 (62.0 %) for composite resin restorations (Tables I-IIIC). The components of total income per restoration type are summarised in Fig. 1.

Discussion

This is a first study in which the cost of ART and conventional restorative dentistry has been compared in the costing structure of a modern dental school setting. Indeed to our knowledge no cost analysis has been published on any aspect of South African dental schools. The model for this study was based on that undertaken by Smit and Holtshousen,[5] who analysed the cost efficiency of a public services mobile dental surgery. While the two study subjects are hardly comparable the investigative route appeared suitable in the absence of any other similar endeavour. Our study shows that the ART approach can be cost-effectively implemented within the SOHS, University of the Witwatersrand. Furthermore ART can be practised as a viable economic alternative to conventional treatment procedures within the clinical setting. This is not only from a direct cost point of view but with the added spin-off of reduced maintenance costs of dental equipment which are not used in the ART approach.

After much debate we decided to exclude salary per time of procedure from the total fixed costs of the restorations. Students are responsible for the majority of the restoration work in the teaching clinics which were the site for evaluation. However, for completeness we include the following should there be a wish to undertake a

Table IIA. **Capital cost of one composite restoration**

N	Item	Qty	Year manufactured	Estimated depreciation (in years)	Purchase price in Rand	Capital per year in Rand
Single surface						
01.	Fast handpiece	1	2000	5	2 500.00	500.00
2.	Slow handpiece	1	2000	5	3 000.00	600.00
03.	Rubber dam	1	2000	5	150.00	30.00
04.	Curing light	1	2000	5	6 000.00	1 200.00
05.	Dental tweezers	1	2000	5	150.00	30.00
06.	Dental probe	1	2000	5	150.00	30.00
07.	Syringe	1	2000	5	200.00	40.00
08.	Diamond bur	1	2000	2	12.00	6.00
09.	Steel bur	1	2000	2	12.50	6.25
10.	Mouth mirror	1	2000	5	150.00	30.00
11.	Plugger	1	2000	5	150.00	30.00
12.	Carver	1	2000	5	150.00	30.00
13.	Dental chair	1	2000	5	28 750.00	5 750.00
14.	Suction unit	1	2000	5	10 100.00	2 020.00
15.	Dental unit	1	2000	5	15 000.00	3 000.00
16.	Autoclave	1	2000	5	14 500.00	2 900.00
	Total per annum					16 202.25
	Total per month					1 350.18
	Total per day					67.50
	Total per hour					8.43
	Total per minute					0.14
	Total per restoration (22 min)					3.09
Multiple surface						
10.	Matrix retainer	1	2000	5	150.00	30.00
	Total per annum					16 232.25
	Total per month					1 352.69
	Total per day					67.63
	Total per hour					8.45
	Total per minute					0.14
	Total per restoration (22 min)					3.10

1 month = 20 working days; 1 working day = 8 hours.

Table 11B. Variable costs of one composite restoration

N	Item	Quantity needed	Quantity per pack	Price per pack in Rand	Price per quantity needed in Rand
Single surface					
01.	Composite (Z100)	1	100	500.00	5.00
02.	Articulating paper	1 sheet	100	150.00	1.50
03.	Cotton wool rolls	4	100	150.00	6.00
04.	Gauze	2 pads	100	25.00	0.50
05.	Lining cement (Vitrabond)	1	100	400.00	4.00
06.	Local anaesthetic cart.	1	100	250.00	2.50
07.	Injection needle	1	100	50.00	0.50
08.	Mouth mask	1	100	60.00	0.60
09.	Glove	1 pair	50 pairs	30.00	0.60
10.	Hibiscrub (hand disinf.)	5 ml	500 ml	40.00	0.50
11.	Ultra swipes (surface disinf.)	1 wipe	160 wipes	165.00	1.03
12.	Scotchbond plus	1	100	874.00	8.74
	Total per restoration				31.47
Multiple surface					
5.	Matrix band	1	12	20.00	1.67
6.	Wedges	2	100	65.00	0.65
	Total per restoration				33.79

Table 11C. Income statement: for 1 × composite restoration (SOHS)

Single surface			
1.	Output value	R 91.00	
2.	Variable cost	R 31.47	
3.	Contribution margin	R 59.53	
4.	Fixed costs	R 3.09	
	4.1. Salary	R 0.00	
	4.2. Capital cost	R 3.09	
5.	Net income	R 56.44	— *62.0%
Multiple surface			
1.	Output value	R 112.00	
2.	Variable cost	R 33.79	
3.	Contribution margin	R 78.21	
4.	Fixed costs	R 3.10	
	4.1. Salary	R 0.00	
	4.2. Capital cost	R 3.10	
5.	Net Income	R 75.11	— *67.0 %

* Net income as a percentage of output value.

similar comparison. Duration of procedure for one amalgam and one composite restoration is estimated as an average of 22 minutes;[8] ART restorations are estimated to take 19.8 minutes.[9] According to this, the estimated price difference attached to the duration of the restorative procedures is marginal and we feel that the inclusion of a calculated salary per duration of procedure would have no significant impact on our findings. Other factors not related to the type of restoration, but rather to factors intrinsic to the treatment, i.e. size of cavity, location in the mouth and skills of the operator are major determinates of the length of time needed per procedure and are also not considered.

A possible limitation of our study is the simplistic manner of our costing exercise. Paradoxically herein lies its greatest strength. We are aware that items such as service and maintenance costs of dental equipment, as well as support staff salaries would certainly be incorporated into a more sophisticated economic exercise than this one. However this analysis pertains to the costing of the three treatment types within the clinic setting and Central Stores of the SOHS and such variables then remain standard. While a detailed breakdown of all factors impacting on the three dental restorative procedures studied, within the specifics of the SOHS, may not conclude with exactly the Rand costs of our study, it will not affect the essential finding of the study, i.e. that ART is a cost-effective treatment within the clinic setting. The effort required to complete a more detailed task would cause the analysis to become grossly unwieldy and equally questionable. We feel that the simplistic approach adopted in this study, in which we have selected items directly pertaining to the treatments as such, can be usefully applied in similar comparative studies.

Finally we acknowledge that fees according to the scale of benefits as determined by BHF are not charged at the SOHS. In the absence of suitable alternatives we used the BHF fees as a more realistic value of restorations rendered. The assumption that the output value of an ART restoration equals amalgam can be debated. However, a final definition of the exact output value of an ART filling is only possible after the inclusion of ART in the scale of benefits.

The high net income reflected in our study is a reflection of the singularity of our study environment (SOHS) and will certainly not be true for the private practitioner at large. The peculiarities intrinsic to a dental teaching hospital with its economic idiosyncrasies, curious subsidisation policies and conflicting teaching and service needs form a unique health and economic microcosm divorced from the private sector. Such a high net income is unrealistic and cannot be compared with the actualities encountered in the private sector and this must be noted. However the 50 % savings achieved on materials and capital outlay will remain constant be it private practitioner or dental school clinic.

Conclusion

Economic analysis is used to help set priorities, predict outcomes, evaluate costs and consequences of a course of action in dental health care. While the clinical effectiveness of ART has already been demonstrated,[7] this study shows that ART is also a cost-effective means of oral health care within a modern dental clinic. The ART approach can be undertaken at approximately 50% of the capital costs of conventional restorative dentistry within the SOHS. As such this finding would apply to all similar South African teaching dental

Table III A. Capital costs of one ART restoration

N	Item	Qty	Year manufactured	Estimated depreciation (in years)	Purchase price in Rand	Capital per year Rand
Single surface						
01.	Excavator small	1	2000	5	150.00	30.00
02.	Excavator medium	1	2000	5	150.00	30.00
03	Excavator large	1	2000	5	150.00	30.00
04.	Hatchet/hoe	1	2000	5	150.00	30.00
05.	Mixing spatula	1	2000	5	150.00	30.00
06.	Plugger	1	2000	5	150.00	30.00
07.	Carver	1	2000	5	150.00	30.00
08.	Dental chair	1	2000	5	28 750.00	5 750.00
09.	Autoclave	1	2000	5	14 500.00	2 900.00
10.	Mouth mirror	1	2000	5	150.00	30.00
11.	Dental probe	1	2000	5	150.00	30.00
12.	Dental tweezers	1	2000	5	150.00	30.00
	Total per annum					8 950.00
	Total per month					745.83
	Total per day					37.29
	Total per hour					4.66
	Total per minute					0.08
	Total per restoration (22 min)					1.58
Multiple surface						
10.	Matrix retainer	1	2000	5	150.00	30.00
	Total per annum					8 980.00
	Total per month					748.33
	Total per day					37.42
	Total per hour					4.68
	Total per minute					0.08
	Total per restoration (22 min)					1.58

1 month = 20 working days; 1 working day = 8 hours.

Table III B. Variable costs of one ART restoration

N	Item	Quantity needed	Quantity per pack	Price per pack in Rand	Price per quantity needed in Rand
Single surface					
01.	Glass ionomer	180 mg	18 g	634.49	6.34
02.	Vaseline	2 mg	50 g	5.00	0.01
03.	Articulating pape	1 sheet	100	150.00	1.50
04.	Cotton wool rolls	4	100	150.00	6.00
05.	Cotton pellets	10	2 500	50.00	0.20
06.	Gauze	2 pads	100	25.00	0.50
07.	Mouth mask	1	100	60.00	0.60
08.	Gloves	1 pair	50 pairs	30.00	0.60
09.	Hibiscrub (hand disinf.)	5 ml	500 ml	40.00	0.50
10.	Ultra swipes (surface disinf.)	1 wipe	160 wipes	165.00	1.03
	Total per restoration				17.28
Multiple surface					
7.	Matrix band	1	12	20.00	1.67
8.	Wedges	2	100	65.00	0.65
	Total per restoration				19.60

Table III C. Income statement: for 1 × ART restoration (SOHS)

Single surface			
1. Output value	R 77.00		
2. Variable cost	R 17.28		
3. Contribution margin	R 59.72		
4. Fixed costs	R 1.58		
4.1. Salary	R 0.00		
4.2. Capital cost	R 1.58		
5. Net income	R 58.14	—	*75,5 %
Multiple surface			
1. Output value	R 96.20		
2. Variable cost	R 19.60		
3. Contribution margin	R 76.60		
4. Fixed costs	R 1.58		
4.1. Salary	R 0.00		
4.2. Capital cost	R 1.58		
5. Net income	R 75.02	—	*77.9 %

* Net income as a percentage of output value.

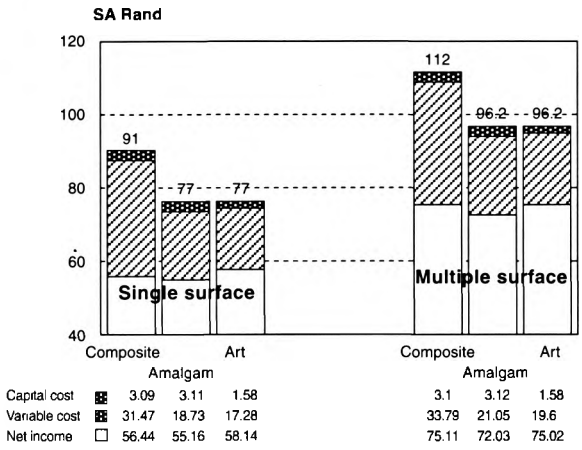

Fig. 1. Components of total costs and income per restoration type in South African Rand for a single and multiple surface restoration. The figure at the top of each bar is the output value (BHF).

facilities. These findings suggest further reduced maintenance costs of dental equipment by using ART in the dental practice providing comprehensive dental care. This is the first study in which the cost of ART and conventional restorative dentistry has been compared in the costing structure of a clinic setting.

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