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Original Research Article

Cost minimization analysis of antimalarials in India

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ABSTRACT

Objective: To assess the cost difference of various branded and generic antimalarial drugs available in the Indian market.**Background:** Malaria is a highly prevalent infectious disease in India. There are innumerable brands of antimalarials in the market with variation in the cost. The cost of treatment is an important aspect of health economics. Cost-related poor patient compliance is a significant problem resulting in incomplete treatment which tends to increase morbidity and mortality. Hence this study was done to assess the cost variation of various preparations of antimalarials (branded and generic) available in India.**Materials and Methods:** The maximum and minimum price of each antimalarial drug in rupees (INR) was noted by using CIMS July to October 2018 edition, Drug Today July to October 2018, and www.1mg.com. The cost ratio and the percentage of cost variation for individual drugs were calculated and compared.**Results:** There is a very high variation in the cost of various antimalarials available in India. The highest variation in cost ratio and percentage of cost variation was seen with Chloroquine 500 mg, Mefloquine 250 mg, and Sulfadoxine-Pyrimethamine 500+25 mg. The lowest cost ratio and percentage of cost variation were seen with Artesunate 120 mg injection, Arteether-Lumefantrine 20 + 120 mg, and Artemether 40 mg.**Conclusion:** This study reveals the need to further improve the drug price regulatory mechanism concerning antimalarials available in India to improve patient compliance and thus cure rates of malaria.© This is an open access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

1. Introduction

Pharmacoeconomics is defined as the description and analysis of the costs of drug therapy to health care systems and society. Pharmacoeconomics involves identifying, measuring, and comparing the costs and consequences of pharmaceutical products and services.¹ There are four basic types of pharmacoeconomic studies; cost-minimization analysis, cost-effectiveness analysis, cost-utility analysis, and cost-benefit analysis.^{2,3} Cost-minimization analysis also called cost analysis measures and compares input costs and assumes outcomes to be equivalent. Thus, in the cost-minimization analysis cost of two or more alternatives is compared without regard to outcome. Cost

minimization analysis has the advantage of being the simplest pharmacoeconomic study because the outcomes are assumed to be equivalent. Thus, in the cost-minimization analysis, only the costs of the intervention are compared.^{3,4}

The consideration of the cost of treatment is one of the important aspects of health economics. The cost of the acquisition of medicines is one of the major costs that the patient has to bear. Cost related to poor patient compliance is a significant problem throughout the world. However, the physicians tend to prescribe branded preparations over generic ones as they assume that the branded preparations are more superior to generic preparations of the same drug.²

Various antimalarial drugs currently used are the aminoquinolines which include Chloroquine, Amodiaquine, Piperaquine; quinoline such as Mefloquine; cinchona

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alkaloids which include Quinine, Quinidine; biguanide such as Proguanil; diaminopyrimidine such as Pyrimethamine. Aminoquinolines also include Primaquine and Tafenoquine. Sulphonamides like Sulfadoxine, Sulfamethopyrazine, and antibiotics like Tetracycline, Doxycycline, Clindamycin are also used. Sesquiterpene lactones including Artesunate, Artemether, Arteether, Arterolane, and amino alcohols such as Halofantrine, Lumefantrine along with naphthyridines such as Pyronaridine and naphthoquinone such as Atovaquone are commonly used for the management of the malarial disease.⁵⁻⁸

It is a commonly observed fact that there is a gross variation in the cost of different branded preparations of the same drug. The reason for the above observation is that the pharmaceutical companies tend to produce both branded as well as generic versions of the same drug and market the branded preparations at a higher cost.⁹ It has been observed that the generic and branded version of the same drug prepared by the same company does not differ markedly in terms of bioavailability or other parameters. This difference in cost has affected both the consumers and the healthcare providers to a great extent and creates confusion regarding which is the most suitable preparation of a drug.¹⁰

The differential pricing of medicines has been taken care of by the Government of India at least to some extent through periodic notification of Drug Price Control Order (DPCO) which fixes the prices of certain drugs that are essential and makes them affordable.¹¹ This in turn is implemented by the National Pharmaceutical Pricing Authority (NPPA).¹²

Hence, the present study was undertaken to analyze the cost difference of various antimalarial drugs available in the Indian market and to highlight the cost variation among different branded and generic preparations available so that whenever possible a cheaper cost-effective medicine can be prescribed to improve patient compliance and to reduce the medicine cost to the patient as well as the total health care costs.

2. Materials and Methods

The prices of various antimalarial drugs were recorded from sources such as CIMS (Current Index of Medical Specialities) July-Oct 2018, Drug Today July to Oct 2018, www.1mg.com. The minimum and maximum cost in rupees (INR) of an antimalarial drug manufactured by different pharmaceutical companies in the same dose strength was noted among all the above sources. The cost of 10 tablets/capsules, one bottle of syrup/drops, and that of one ampoule/vial were calculated. For artemisinin-based oral formulations cost was calculated for 3 days as per WHO and NVBDCP recommendations.

The cost ratio is defined as the ratio of the maximum cost of the drug to the minimum cost of the drug. It was calculated for all the included antimalarial drugs. This

indicates the cost inflation in the prescribed drug with the same chemical compound but with different commercial brands. Cost ratio expresses the cost of drugs in proportion to the costliest and cheapest brand of the drug available in the market. Fixed drug combinations were also evaluated in the same manner as above.

We also calculated the percentage of cost variation which was given by the formula:

Percentage of cost variation = (maximum cost - minimum cost / minimum cost) X 100

3. Results

For pharmacoeconomic analysis, various antimalarials were classified into adult oral formulations, artemisinin-based oral formulations, and parenteral formulations. The prices of a total of thirteen adult oral preparations of antimalarials, ten parenteral preparations, and fourteen artemisinin-based oral formulations manufactured by different pharmaceutical companies were evaluated in the present study.

Cost distribution of various oral antimalarial formulations of antimalarials were given by Table 1. Among the 13 oral formulations there is a gross difference between minimum and maximum cost in most of the formulations. Figure 1 shows cost ratio of various oral antimalarial formulations. Highest cost ratio was seen with Chloroquine 500 mg, Mefloquine 250 mg and Sulfadoxine - Pyrimethamine 500+25 mg. Lowest cost ratio was seen with Quinine 600 mg, Chloroquine 250 mg and Sulfadoxine - Pyrimethamine 750+37.5 mg. Percentage of cost variation of various oral antimalarial formulations were given by Figure 2. Highest percentage of cost variation was seen with Chloroquine 500 mg, Mefloquine 250 mg and Sulfadoxine - Pyrimethamine 500+25 mg. Lowest percentage of cost variation was seen with Quinine 600 mg, Chloroquine 250 mg and Sulfadoxine - Pyrimethamine 750+37.5 mg.

Table 2 Shows cost distribution of various artemisinin based oral formulations. Among the 14 artemisinin based oral formulations there is a significant difference between minimum and maximum cost in most of the formulations. Cost ratio of various artemisinin based oral formulations were given by Table 3. Highest cost ratio was seen with Artesunate - Sulfadoxine - Pyrimethamine 100+500+25 mg, Artesunate 100 mg and Artesunate 50 mg. Lowest cost ratio was seen with Artemether 40 mg, Arteether - Lumefantrine 20+120 mg, Artesunate - Sulfadoxine - Pyrimethamine 200+750+25 mg and Artesunate - Mefloquine 100+200 mg. Figure 3 shows percentage of cost variation of various artemisinin based oral formulations. Highest percentage of cost variation was seen with Artesunate - Sulfadoxine - Pyrimethamine 100+500+25 mg, Artesunate 100 mg and Artesunate 50 mg. Lowest percentage of cost variation was seen with Arteether - Lumefantrine 20+120 mg, Artemether 40 mg and Artesunate - Mefloquine 100+200 mg.

Table 1: Cost distribution of various oral antimalarial formulations

S.No	Drug	Formulation	Strength	No of tablets	Minimum cost(rs)	Maximum cost(rs)
1	Chloroquine	Tablet	250 mg	10	33	55
2	Chloroquine	Tablet	500 mg	10	5.86	268
3	Amodiaquine*	Tablet	200mg	10	5	-
4	Mefloquine	Tablet	250 mg	10	14.89	632.21
5	Mefloquine	Tablet	300 mg	10	28.63	699.6
6	Quinine	Tablet	600 mg	10	80.96	132.37
7	Quinine	Tablet	2.5 mg	10	8.90	21.28
8	Primaquine	Tablet	7.5 mg	10	12.9	46.87
9	Primaquine	Tablet	15 mg	10	7.5	62.3
10	Sulfadoxine-	Tablet	500 mg + 25 mg	10	9.1	360
11	Pyrimethamine	Tablet	750 mg + 37.5 mg	10	24.05	45.25
12	Proguanil	Tablet	100 mg	10	39.5	80
13	Sulfamethoxazole- Pyrimethamine	Tablet	500 mg + 25 mg	10	27.5	196.66

Cost Ratio and Percentage of cost variation of various parenteral antimalarial formulations is given in Figure 4 and Table 4 respectively. Highest percentage of cost variation was seen with Arteether 150 mg, Quinine 300 mg and Quinine 600 mg. Lowest percentage of cost variation was seen with Artesunate 120 mg, Artemether 80 mg and Artesunate 60 mg.

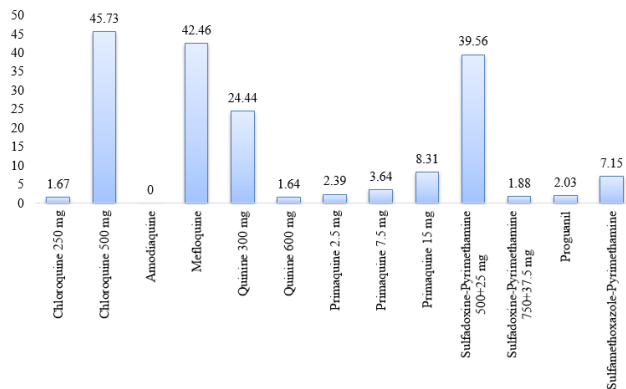


Fig. 1: Cost Ratio of various oral antimalarial formulations

4. Discussion

India has a high incidence of malaria because of unstable malaria transmission with increased intensity of transmission during rains and poor or absent immunity to malarial parasite among the Indian population.^{9,10}

Given the magnitude of malaria in our country antimalarial drugs should be made available at prices which will not be an economic burden on the largely poor population of our country. In India many pharmaceutical companies sell a drug in different generic and brand names and this has led to wide variation in the price of generic and branded formulation of these drugs. Other

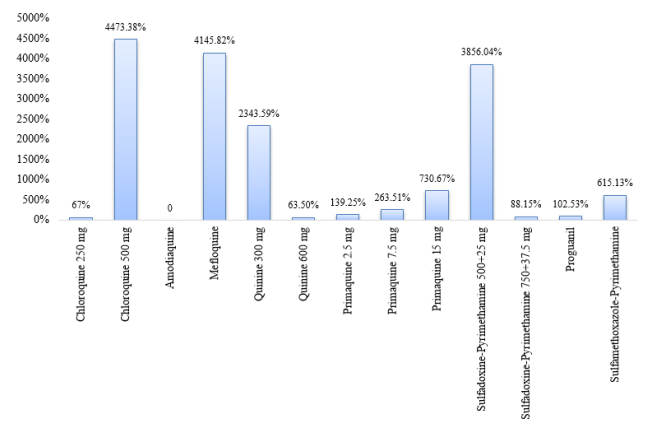


Fig. 2: Percentage of cost variation of various oral antimalarial formulations

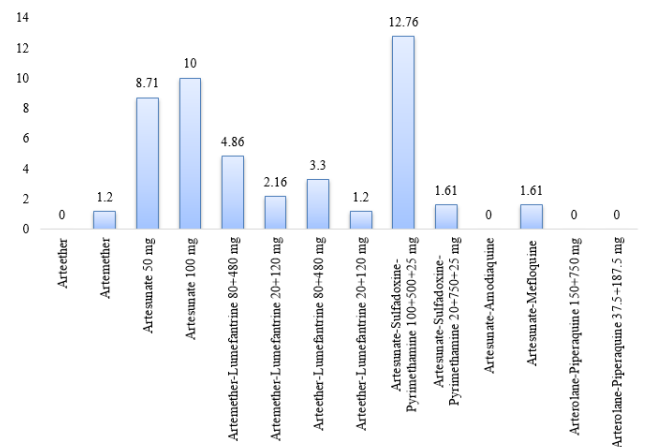


Fig. 3: Cost Ratio of various artemisinin based oral formulations

Table 2: Cost distribution of various artemisinin based oral formulations

S.No	Drug	Formulation	Strength	No of tablets	Minimum Cost(Rs)	Maximum Cost(Rs)
1	Arteether*	Tablet	50 mg	6	113.20	-
2	Artemether	Capsule	40 mg	6	108	130
3	Artesunate	Tablet	50 mg	6	24	209.07
4		Tablet	100 mg	6	120	1200
5	Artemether-	Tablet	80 mg + 480 mg	6	46.92	228
6	Lumefantrine	Tablet	20 mg + 120 mg	6	52	112.5
7	Arteether-	Tablet	80 mg + 480 mg	6	54.62	180
8	Lumefantrine	Tablet	20 mg + 120 mg	6	66	78.91
9	Artesunate-	Tablet	100 mg + 500 mg +	3	14.81	189
10	Sulfadoxine- Pyrimethamine	Tablet	25 mg 200 mg + 750 mg + 25 mg	3	184	296
11	Artesunate- Amodiaquine*	Tablet	100 mg + 300 mg	6	117.91	-
12	Artesunate- Mefloquine	Tablet	100 mg + 200 mg	6	298.35	479.5
13	Arterolane-	Tablet	150 mg + 750 mg	3	198	-
14	Piperaquine*	Tablet	37.5 mg + 187.5 mg	3	75	-

Table 3: Percentage of cost variation of various artemisinin based oral formulations

S.No	Drug	Strength	Percentage of cost variation
1	Arteether	50 mg	-
2	Artemether	40 mg	20.37%
3	Artesunate	50 mg	771.13%
4		100 mg	900.00%
5	Artemether-Lumefantrine	80 mg + 480 mg	385.93%
6		20 mg + 120 mg	116.36%
7	Arteether-Lumefantrine	80 mg + 480 mg	229.55%
8		20 mg + 120 mg	19.56%
9	Artesunate-Sulfadoxine-	100 mg + 500 mg + 25 mg	1176.16%
10	Pyrimethamine	200 mg + 750 mg + 25 mg	60.87%
11	Artesunate-Amodiaquine	100 mg + 300 mg	-
12	Artesunate-Mefloquine	100 mg + 200 mg	60.72%
13	Arterolane-Piperaquine	150 mg + 750 mg	-
14		37.5 mg + 187.5 mg	-

Table 4: Percentage of cost variation of various parenteral antimalarial formulations

S.No	Drug	Strength	Percentage of cost variation
1	Chloroquine	40mg	157.35%
2		300 mg	1263.64%
3		600 mg	1064.94%
4	Quinine	75 mg	837.50%
5		120 mg	-
6	Artemether	150 mg	2308.54%
7		80 mg	37.97%
8	Artesunate	60 mg	136.36%
9		120 mg	12.03%
10	Alpha- Beta Arteether	150 mg	279.42%

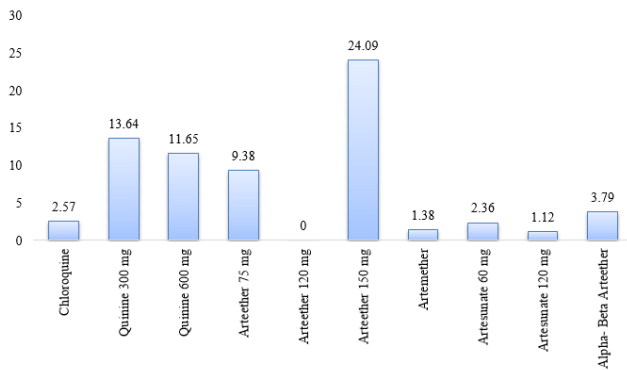


Fig. 4: Cost ratio of various parenteral antimalarial formulations

factors like government regulations, cost of raw materials, drug distribution and promotion costs, economic goals of company, etc also contribute to the wide variation in the price of drugs.¹² There is a false belief among the people that the branded and costlier drugs are more effective or superior over generic drugs. Physicians and consumers may suspect a drug to be of low quality from its low market price, non-innovator brand and the look of the product, but none of these can perfectly identify substandard and counterfeit drugs.²

The cost variation assumes significance when the cost ratio exceeds 2 and percentage of cost variation exceeds 100. The present study reveals that there is a great variation in the prices of different formulations of antimalarials available in the Indian market.

The highest cost ratio was seen with

1. Chloroquine (500 mg) – 45.73
2. Mefloquine (250 mg) – 42.46
3. Sulfadoxine-Pyrimethamine (500 mg + 25 mg) – 39.56
4. Quinine (300 mg) – 24.44
5. Arteether (150 mg injection) – 24.09.

The lowest cost ratio was seen with

1. Artesunate (120 mg injection) – 1.12
2. Arteether-Lumefantrine (20 mg + 120 mg) – 1.20
3. Artemether (40 mg) – 1.20
4. Artemether (80 mg injection) – 1.38
5. Artesunate-Mefloquine (100 mg + 200 mg) – 1.61.

The highest percentage of cost variation was seen among

1. Chloroquine (500 mg) – 4473.38%
2. Mefloquine (250 mg) – 4145.82%
3. Sulfadoxine - Pyrimethamine (500 mg + 25 mg) – 3856.04%
4. Quinine (300 mg) – 2343.59%
5. Arteether (150 mg injection) – 2308.54%.

The lowest percentage of cost variation was seen among

1. Artesunate (120 mg injection) – 12.03%
2. Arteether-Lumefantrine (20 mg + 120 mg) – 19.56%
3. Artemether (40 mg) – 20.37%
4. Artemether (80 mg injection) – 37.97%
5. Artesunate-Mefloquine (100 mg + 200 mg) – 60.72%.

Thus, an expensive brand can cost a patient more than ten times the price of a cheaper brand of the same drug. This reflects a serious concern in the context of India where 50-90% of cost of medicines are still borne by the patient themselves. This high cost of purchasing medicines is a significant factor leading to poor compliance.^{4,5} Clinician's false belief of effectiveness or superiority of branded drugs over generic drugs often results in prescription of costly drugs, when cheaper alternatives are readily available. This often leads to non-compliance or sometimes partial compliance in the patients. Medication compliance refers to the extent of conformity to treatment recommendation with respect to the timing, dosage, frequency and duration of a prescribed medicine. It can also be described as the degree to which a patient correctly follows medical advice. Other factors contributing to patients non-compliance include: drug formulation, improvement of symptoms, frequent dosing, side effects of drugs, etc.^{2,3}

Hence prescription of good quality generic drugs which are as effective as branded drugs, would lead to improved compliance by the patient and thus lead to an improvement in the outcomes of malaria.

5. Conclusion

The present study reveals that there is a need to further improve the drug price regulatory mechanism as it was found that there was a very wide variation (more than 1000%) of some of the commonly used antimalarial drug preparations. Physician's knowledge of such price variation of commonly used antimalarials and their due consideration of the economic status of the patient while prescribing antimalarials can greatly improve the drug compliance by patient and thus lead to improved cure rates of malaria worldwide.

6. Conflicts of Interest

All contributing authors declare no conflicts of interest.

7. Source of Funding

None.

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