

# Cost-effectiveness of extracorporeal shock wave lithotripsy in a poor resource setting: The Okada, Nigeria experience

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## ABSTRACT

**Background:** The first extracorporeal shock wave lithotripsy (ESWL) used in Nigeria was at Igbinedion Hospital and Medical Research Centre (IHMRC), Okada in 1992 and it functioned for 6 consecutive years. The objectives of this study were to analyze the cost-effectiveness of the procedure and highlight the associated factors that led to its failure. **Methods:** A retrospective study of medical records and publications associated with the use of ESWL at IHMRC, Okada, for the period of 1992 to 1998. The study was conducted between January 2003 and November 2008. Unclassified authentic information relating to the use of ESWL and treatment of upper urinary tract stones was obtained from the IHMRC Okada and some government hospitals on hospital bills. Relevant documents in public domains related to the national and international wages and emoluments of medical workers and socioeconomic development of Nigeria within the time the ESWL functioned were studied. **Result:** A total of 32 patients were treated with 51 treatment sessions which is an average of nine patients per year and an average of two treatment sessions per patient were involved. The reasons for the low patronage were the extremely low stone formation rate of Nigerians, poverty, and out-of-pocket payment system. In addition, each treatment session of ESWL at Okada cost an average of \$681.8 compared to \$227.3 for open nephrolithotomy in a nearby high profile teaching hospital. The IHMRC, Okada, paid an average annual salary of ₦180,000 (\$8,181.8) for each medical consultant compared to ₦120,000 (\$5,454.5) paid by federal teaching hospitals in Nigeria within the period. Expatriate consultant doctors from Europe and USA who initially manned the lithotripter at IHMRC, Okada, were paid much higher salaries. Average annual income of \$5,909 for each of the 6 years amounting to a total of \$34,771.7 for the six years was realized which could not maintain staff salaries in the hospital leading to staff emigration, decline of the hospital services, and eventual closure of the ESWL procedure center in the hospital in 1998. **Conclusion:** ESWL at Okada was not cost-effective both to patients and the hospital management. Despite these, ESWL is desirable in poor-resource countries because of its noninvasiveness, low morbidity, and usability in patients who are unfit for open surgery. Purchasing high technological medical equipment as commodities by sub-Saharan Africans without considering the prevalence of diseases they are meant to cater for, their maintenance for steady function during useful lifespan, their cost-effectiveness and how to recoup the money spent on investments depletes the scarce foreign exchange reserve of the home countries and is eventually counterproductive as exemplified by this case.

**Key words:** Calculi, cost, cost-effectiveness, developing countries, extracorporeal shock wave lithotripsy, high personnel cost, Nigeria, poverty, prevalence

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## INTRODUCTION

Stone formation in the urinary tract affects 4–20% of the population in the economically rich, highly industrialized countries whose citizens feed on high protein diet.<sup>1,2</sup> Over 60% of stone formation in these countries are idiopathic affecting mostly the upper urinary tract of adults.<sup>1-3</sup> In contrast, in many developing countries including Nigeria, the prevalence of stone formation is very low and over 60% are due to infection or obstruction affecting mostly the lower urinary tract.<sup>1-5</sup> On the prevalence of urinary tract stone in Nigeria, Mbonu *et al.* in Enugu recorded an incidence of 13/100,000.<sup>6</sup> Monu in Benin City recorded 6.3/100,000.<sup>7</sup> Esho in Lagos recorded 7/100,000.<sup>8</sup> Ekwere in Calabar<sup>9</sup> recorded 19.1/100,000 whereas Hassan and Mabongunje in Zaria reported incidence of 9.6/100,000.<sup>10</sup> Extracorporeal shock wave lithotripsy (ESWL) is a nondrug, nonsurgical, and noninvasive procedure for the treatment of upper urinary tract stones.<sup>11,12</sup> It uses repeated shockwaves directed at the stones to crush them into very fine fragments that can be effectively excreted in the urine. The procedure is applied over the skin without the use of general anesthesia in cooperative patients. It is presently the treatment of choice for upper urinary stones of measuring < 2 cm in diameter [Figure 1]. It was introduced into clinical use in early 1980s and rapidly gained popularity in Europe and North America because of its effectiveness and noninvasive approach in the treatment of upper urinary tract stones.<sup>4,5</sup> Stones in lower urinary tract [Figure 2], are unsuitable for treatment with ESWL.<sup>1-5</sup> The first ESWL performed in Nigeria was in 1992 at Igbinedion Hospital and Medical Research Centre (IHMRC), Okada, Edo State.<sup>4</sup> The hospital was a privately owned tertiary hospital with state-of-the-art facilities at the inception. It was opened with a great fanfare targeting the rich, government functionaries, the diplomatic community, and the high business class. This study examines the cost effectiveness of the procedure at Okada, Nigeria.



**Figure 1:** Renal sonogram showing multiple intracalyceal renal stones in an adult Nigerian, in ideal locations for treatment with extracorporeal shock wave lithotripsy

## METHODS

This was a retrospective study involving the hospital records of IHMRC, Okada. The study was conducted between January 2003 and November 2008. The data at Igbinedion Hospital were obtained between January 4 and July 31, 2003. The costs of open surgeries in other hospitals for the period covering January 1992 to December 1998, were obtained between July 1, 2004 and November 30, 2008 from the accounts departments of these hospitals. Relevant data involving parameters associated with ESWL performed at Okada from 1992 to 1998 were extracted and studied. Literature search was also conducted on local and international journals and publications on ESWL at Okada.

## RESULTS

ESWL performed at Okada used a Siemens Lithostar lithotripter (Siemens Healthcare, Germany, 1990), with shock wave excitation voltage of 13–19 KV. It was installed in 1992 at Okada in Edo State, Nigeria, in a privately owned well equipped tertiary hospital. The machine functioned for 6 consecutive years.<sup>4</sup> During this period (6 years), a total of 32 patients were treated aged 20–65 years with a total of 51 treatment sessions. There were 25 males and 7 females with M:F ratio of 4:1. Stone sizes were 1.5–3 cm in diameter. Plain radiography of the kidney, ureter and bladder areas were performed before and after the procedure. Excretory urography was performed in all patients before and after each ESWL treatment session to ascertain the functional state of the kidney and any residual stone. During treatment, intravenous contrast was used to aid identification of the kidney and stone to know when the stone has been completely crushed. Abdominal sonography was also used before and after each treatment session to monitor the stones, their positions, and disappearance or residual fragments. Also, some patients had computed



**Figure 2:** Plain radiograph of the pelvis showing intravesical stones in an adult Nigerian as a result of bladder outlet obstruction. These stones are not in ideal location for treatment with extracorporeal shock wave lithotripsy

tomography (CT) scans done at the University College Hospital (UCH), Ibadan, either for stone diagnosis before the ESWL procedure or recheck for complete clearance after the procedure or both. However, the costs of the CT scans were not added to the cost of ESWL at Okada. Other parameters are summarized in the Table 1

The official exchange rate of Naira to Dollar in the study period was 22 Naira (N22) to one US Dollar (\$1).<sup>13-15</sup> The basic minimum wage of federal civil servants per month varied from N550 (\$25) in 1995 to N1500 in 1997 (\$168.18). The annual salary of a medical consultant in federal civil service in Nigeria in 1995 was about ₦120,000 (\$5,454.5) whereas at Igbinedion Hospital, Okada, it was ₦180,000 (\$8181.8). The method of payment of hospital bill was cash in both the private and government hospitals, as health insurance was not available in the country at that time. However, high-ranking government officials and top company executives had their bill paid by the government or organizations that they worked for, respectively. Each person who underwent a retreatment spent multiple of the amount for the cost of a single treatment option [Table 1]. ESWL at Okada though required 2 days admission stay instead of the 8–10 days for open nephrolithotomy had an average total bill of about N15,000 (\$681.8) compared to N5,000 (\$227.3) for open nephrolithotomy.

## DISCUSSION

Only 32 patients were treated with ESWL at Okada, Nigeria, in 6 years.<sup>4</sup> Whereas in Canada, Jewett treated 1000–2000 patients per year and Lehtoranta in Finland treated 425 patients in 2 years.<sup>11,12</sup> Poverty, low stone prevalence, and cash payment system may be largely responsible for this. In 1995, Nigeria's debt burden was estimated at \$28,455 million and her per capita income was \$310.<sup>14,15</sup> Even though, Nigeria is considered potentially a rich nation in terms of its natural and human resources, over 70% of Nigerians are poor, mostly rural dwellers, have no access to quality health care, and depend on traditional nonorthodox medical treatment methods based on herbal remedies and divination.<sup>16,17</sup> These methods of treatment are cheap and readily available; however, diseases requiring surgeries which were treated by this method ended in many

complications and disaster.<sup>16-18</sup> Nigeria's orthodox medical practice has cumbersome payment system, relying heavily on out-of-pocket spending.<sup>18,19</sup>

The average cost to a patient after discharge from a treatment session of ESWL from 1992 to 1998, which was US \$681.8 per treatments session is less than the cost per single ESWL treatment as recorded in developed countries. Jewett *et al.*<sup>11</sup> in Canada recorded \$2,226 and Aronne *et al.*<sup>20</sup> in New York recorded \$9,290 per treatment session. Carlsson *et al.*<sup>21</sup> in Sweden recorded 2,172 Pounds Sterling. Charig *et al.* in Britain recorded 1,789 Pounds for ESWL compared to 3500 Pounds for open surgery.<sup>22</sup>

The cost of other major surgeries such as nephrolithotomy performed in government hospitals in Nigeria was extremely lower than the cost of ESWL performed at Okada at that time. Even though the indications for ESWL and surgery for upper urinary stones are different, in the study environment, surgery was the only treatment option and ESWL was only an alternative for those cases of upper urinary stones that fit into its indications. For instance, the average total hospital bill after nephrolithotomy including investigations, drugs, and hospital bed fees in a nearby teaching hospital in 1996–1998 was about N5,000 (\$227.3). Morbidity and mortality are however worse in surgical treatments than ESWL as no mortality was recorded with ESWL at Okada<sup>4</sup> and also considering the reports from other authors.<sup>11,20</sup> The average hospital stay for open surgical therapies for renal stone in Nigeria in 1992–1998 was 8–12 days whereas for the ESWL in Okada, it was 2 days.<sup>4</sup> The findings on the cost is at variance with the reports of authors from other parts of the world, particularly Europe and America, which recorded that ESWL was considerably cheaper than open surgeries.<sup>11,20-22</sup>

The minimum wage of government workers in Nigeria ranged from N550 (\$25) in 1992 to N1500 (\$168) in 1998 due to rapid severe over devaluation of Naira.<sup>23</sup> The total monthly take home pay of a house officer in 1994 was N5,400 (\$245.4). Therefore, in the context of the Nigerian environment and economy, the cost of ESWL performed at Okada was outside the reach of the average citizen. Yet renal stone is most common in the lower socioeconomic group in most developing countries including Nigeria.<sup>1-3</sup>

The average annual salary of medical consultants in federal teaching hospitals in Nigeria within the study period was ₦120,000 (\$5,454.5). This is lower than the pay for the same category of staff at IHMRC, Okada, which was N180,000 (\$8,181.8) per annum. Furthermore, the salaries paid to expatriate consultant doctors from Europe and USA who initially manned the Igbinedion hospital were much higher. The estimated total revenue generated by the ESWL including associated cost of boarding, laboratory and radiology investigations was \$34,727.7 in the 6 years that

**Table 1: Costs for different treatment sessions and average total income accruing to the hospital from ESWL treatment in 1992-1997 (₦22=\$1)**

Treatment session	Cost (₦)	Cost (US \$)	Number of patients (%)	Total income (US \$)
1	15,000	681.8	18 (56.3)	12,272.4
2	30,000	1363.6	11 (34.4)	14,999.6
3	45,000	2045.4	1 (3.1)	2,045.4
4	60,000	2727.2	2 (6.2)	5,454.4
Total	-	-	32 (100)	34,727.7

it functioned [Table 1]. It is, therefore, not surprising that after 1996, the hospital found it increasingly difficult to pay staff salaries. This led to staff emigration, decline and eventual closure of the hospital's ESWL procedure in 1998.

Lack of functional and effective health insurance to majority of citizens in sub-Saharan Africa means that out-of-pocket payment is the means through which majority of the citizens continue to pay for the health services.<sup>13,14,24</sup> This is a cumbersome system and puts the poor at great financial stress in the presence of sudden or protracted ill health and these contributed to poor patronage of ESWL at Okada. Medical facilities that are meant for sub-Saharan Africa while aimed at being up to date in scientific technology should also consider the economic purchasing power of the citizens, the prevalence of the disease they are designed for, and the payment system available to majority of the citizens they are meant to cater for.<sup>24,25</sup> This is particularly important since technology is the biggest and strongest driver of cost of medical services worldwide including the developing countries.<sup>24</sup> When compared to the cost of treatment with ESWL in other parts of the world, the ESWL performed at Okada was considerably low, but at the same time very high relative to the purchasing power of the populace that it was meant to cater for. However, the cost of the Lithostar lithotripter was the same whether installed in Europe, USA, or Africa.

In spite of these shortcomings, ESWL is an effective, reliable, and noninvasive method of treating upper urinary tract stones in patients in whom conservative treatment have failed and have no contraindicating lesions for ESWL and those who are not fit for open surgery. Its use is desirable even in low-resource setting such as Nigeria, especially as it is finding uses in orthopedics and general surgery.<sup>26,27</sup> Government or nongovernmental organizations should establish subsidized regional centers in developing countries particularly in sub-Saharan Africa until they become self-sustaining following improved patronage through public sensitization, realization of the importance, and subsequent acceptance. These approaches, we believe, will produce both social and economic benefits in the long run. Establishment of such health facilities should be devoid of the fanfare associated with the Okada experiment which gives the impression that such centers are only for the rich.<sup>28</sup> Rather, education of the populace is necessary to increase their awareness of the advantages of the facilities and treatment options. The use of many treatment sessions of ESWL in Okada for staghorn calculi and multiple radiological investigations used to localize the stones or ascertain their size, position, or fragments before and after each session also added to the cost.<sup>4,29,30</sup>

There are many limitations to this study. The number of patients treated with ESWL (32) is very small and using this small number to generalize for ESWL treatment

in Nigeria as a whole is unsuitable. The fact that the hospital is not fully functional at the time of this study created some limitations to access to full hospital records, making the researchers to rely more on published data on hospital bill concerning ESWL at Okada. In addition, within the time the ESWL functioned at Okada, ESWL was not performed elsewhere in Nigeria and open surgery for renal stone was not performed within Igbinedion hospital. This created major limitations as the comparison of cost effectiveness of similar procedure in different hospitals or alternative procedures within the same hospital could not be done. This study compared the cost of ESWL in a private hospital and open surgery in neighboring high profile government hospitals which is inappropriate. The rural location of Okada town added to the cost as two days of admission were required since the patients came from far places; when compared to where it was done as a day case. In 1985, the Nigerian naira exchanged at 1:1 to the US dollar, but by 1986, naira devaluation and a national Structural Adjustment Program (SAP) was prescribed by the International Monitoring Fund (IMF) as part of conditions for its loan.<sup>13,14</sup> Implementation of these by the government subsequently caused rapid spiral over-devaluation of naira<sup>14,15</sup> without proportionate increase in salaries, making the comparison of costs of services and salaries in Nigerian in 1992-1998 with that of Europe and America rather incongruous.

## CONCLUSION

There were low patronage and high cost of ESWL procedure at Okada in comparison to other treatment options for renal stones in the same geographical region and within Nigeria. Furthermore, there were relatively high personnel cost of ESWL at Okada, Nigeria, and inability of the hospital to recoup the money spent on investment. In other words, the ESWL performed at Okada in 1992-1998 was not cost-effective both to the patients and the hospital management because of the reasons expatiated above.

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## Conflicts of interest

There are no conflicts of interest.

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