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Original Research Article

Impact of battery-powered orthopedic drills on the practice of orthopedic surgery in a resource limited country

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ABSTRACT

Background: The study aimed at assessing the impact of the availability of battery-powered drills on the management of orthopedic cases presenting to the orthopedic unit of the department of surgery at a major teaching hospital serving the southern part of Ghana.

Methods: This study was a single center retrospective study. Authors examined the total number of cases, average time spent on cases in the operating room, and the average patient waiting time for surgery between January 2012 and December 2014. A paired sample t-test was used to evaluate the effectiveness of the orthopedic drills for the pre-and post-intervention periods.

Results: There were statistical significant differences in the total number of cases ($p<0.01$), the average time spent on cases in the operating room ($p<0.01$), and the average waiting time for surgery ($p<0.05$) between January 2012 to June 2013 when manual hand drills were in use and July 2013 to December 2014 when the battery-powered drills were introduced.

Conclusions: The introduction of the battery-powered drills led to a significant improvement in the total number of cases done. There was a reduction in time spent per case in the operating room as well as the average waiting time to having surgery.

Keywords: Audit, Battery-powered drill, Impact, Orthopedics

INTRODUCTION

The delivery of quality healthcare worldwide is heavily depended on effective technology including medical equipment needed for the day to day running of a unit.[1] The health sector in some countries especially the low middle-income countries (LMIC) are poorly funded due to economic constraints. It is believed that almost 80% of the equipment used in the health sectors of these countries is either donated by individuals, organizations or foreign governments. These donated items may have their own limitations such as being out of service.[2] Most orthopedic surgeons in these resource-challenged countries do not usually have access to powered-orthopedic surgical drills which are reliable and safe but unaffordable and are therefore forced to resort to compromises when managing their patients.[3]

They may use manual hand drills, which are highly inefficient and dangerous or industrial hardware drills which are strong, efficient and cheap but they predispose patients to infections as they are difficult to sterilize.[3,4]

In a high-volume trauma hospital whether in a resource-rich or a resource-challenged country, all patients should be promptly taken care of. However, due to the lack of or a limited number of powered orthopedic drills, they tend to wait for days to have surgery or they do not have it done at all.[5] There have been attempts to overcome this challenge of unavailability of drills with the use of fabric and surgical chuck adapters that can be sterilized, coupled to industrial hardware drills. However, the challenge still remains throughout the world due to the inability to commercialize this laudable innovation.[3] This in the long-term impacts negatively on the quality of healthcare delivery.

The purpose of the study was to underscore the importance or otherwise of having adequate resources, example powered orthopedic drills in the provision of orthopedics services in a LMIC. It was an audit of the processes involved in the management of patients in the unit as it sought to enhance the quality of patient care, involved changes to services (manual versus battery powered drills) and compared the previous practice of using manual drills to the standard involving the use of powered drills.[6,7]

METHODS

Following permission from the unit, authors retrospectively reviewed the database between two distinct time periods; the first being January 2012 to June 2013 when mostly manual hand drills were used and July 2013 to December 2014 when eight refurbished battery-powered orthopedic drills that were obtained as a donation from Project Cure in the United States of America were used at the orthopedic and trauma unit of the department of surgery at a major teaching hospital here in Ghana. The inclusion criteria for this study were all orthopedic cases that needed the use of drills. Cases in which drills were not used were excluded. It was hypothesized that the introduction of the battery-powered drills would have a significant effect on the delivery of healthcare (total number of cases done, amount of time spent in theatre per case and the average waiting time for patients) at the unit.

The outcome variables for this study were;

- Total number of cases within the defined time period
- The average duration of the procedure: defined as the start of skin incision to the closure of skin when hand drills and powered drills were used
- Average waiting time: defined as the date the patient presented to the hospital to the actual date of surgery.

Statistical analysis was done using SPSS statistics software version 23 for the interpretation of the variables. Descriptive statistics and the paired sample t-test were conducted where appropriate. The obtained data were expressed as means with a 95% confidence interval (C.I). A p-value of <0.05 was deemed significant.

Pearson correlation test was also done to test any association between the variables.

RESULTS

A total of 1,973 cases were eligible for inclusion in this study. These included 819 cases from January 2012 to June 2013 when hand drills were used and 1154 cases from July 2013 to December 2014 following the introduction of the battery-powered drills.

The cases were made up of external fixations for open fractures, foot and ankle surgeries, open reduction and internal fixation with plates and screws for femur and tibia fractures, locked intramedullary nailing (IMN) for femur and tibia fractures, slipped capital femoral epiphysis, pelvic and acetabula fractures, humerus, clavicle, olecranon, patella, scapula and physeal injuries in the pediatric population.

Table 1: Total number of cases done.

Procedure	Jan 2012 - June 2013	July 2013 - December 2014
External fixation	312	400
Foot and ankle	102	192
Femur Plate fixation	96	110
Femur (IMN)	72	120
Tibia: Plate fixation	70	90
Tibia: IMN	40	51
SCFE	8	20
Pelvic and acetabulum	4	8
Humerus	42	61
Clavicle	4	7
Olecranon	5	9
Patella	14	21
Scapular	3	5
Physeal injuries	47	60

Table 2: Average duration of the procedure (minutes).

Average time spend during surgery	Jan 2012 - June 2013	July 2013 - December 2014
External fixation	65	38
Foot and ankle	60	45
Femur (plate fixation)	80	60
Femur (IMN)	75	50
Tibia (plate fixation)	65	45
TIBIA (IMN)	60	40
SCFE	45	45
Pelvic and acetabulum	140	130
Humerus	78	55
Clavicle	60	40
Olecranon	55	40
Patella	55	42
Scapular	120	80
Physeal injuries	40	40

Table 3: Average waiting time (days).

Procedure	Jan 2012 - June 2013	July 2013 - December 2014
External fixation	1	1
Foot and ankle	14	7
Femur (Plate fixation)	21	7
Femur (IMN)	21	7
Tibia (plate fixation)	18	5
Tibia (IMN)	14	5
SCFE	5	2
Pelvic and acetabulum	14	6
Humerus	16	6
Clavicle	14	7
Olecranon	10	5
Patella	12	4
Scapular	10	6
Physeal injuries	4	2

The total number of cases done, the average duration of the procedure and the average waiting time from January 2012 to December 2014 are presented (Table 1-3).

A paired sample t-test was run to determine whether the introduction of the battery powered drills had any significant effect on the quality of health care delivery in terms of the total number of cases done, the average duration of the procedure and the average waiting time before surgery was done. The results for the descriptive Statistics and t-test, results for the total number of cases, average duration time of the procedure, average waiting time, and the impact of drills are presented (Table 4).

Pearson correlation test was done to test for association between the various parameters. There was a strong positive correlation for the total number of cases done (r=0.986, p<0.01), average time spent in theatre (r=0.927, p<0.01) and the average waiting time (r=0.86, p<0.00) before and after the introduction respectively.

Table 4: Descriptive statistics and t-test results for total number of cases, average duration time of the procedure, average waiting time, and the impact of drills.

Outcome	Pre-drill (Mean±SD)	Post drill (Mean±SD)	n	95% CI for mean difference	r	t	d_f (sig.)
Total cases done	-58.5±80.9	82.4±106.5	14	-41.2 to -6.7	0.986	2.99	13 (0.01)
Average duration of procedure	71.3±27.6	53.6±24.7	14	23.7 to 11.7	0.927	6.37	13 (0.01)
Average waiting time	12.4±6.01	5.0±2.04	14	9.96 to 4.90	0.86	6.35	13 (0.0)

*p< .05

DISCUSSION

The present study focused on examining the impact of the provision of battery-powered drills on the quality of healthcare delivery in a Ghanaian teaching hospital. It is generally accepted that resources for quality health care delivery have grossly become scarce and expensive especially in low middle-income countries (LMIC). This calls for maximization of resource utilization and at the same time reducing patient waiting time.[8] There has been an increased focus on efficiency in the health delivery system as orthopedic cases progressively increase. According to Harders et al, any delays or interruption in the operating theatre process leads to dissatisfaction among both patients and medical staff alike.[9] Patients tend to suffer whilst waiting for surgery and most families of these patients also have problems coping with the delays. Delays in treatment after an injury can result in loss of productivity, increased morbidity, anxiety, physical and psychological pain and suffering.[10]

Authors compared the difference in the total number of cases done within the study period as that is deemed as one of the measures of efficiency in the unit. The significant decreased mean of 23.9 (p<0.01), indicated that following the introduction of the battery powered drills, the total number of cases done increased significantly. This is as a result of the efficient running of the theatre as surgical drills used to be one of the main limiting factors in the unit and this, in turn, did affect the turn over time.

Though the center was the main referral point in the city, there were other hospitals that could manage some of the cases the authors did hence patients were referred there due to the anticipated delays. However, that process stopped or was minimized due to the efficiency that came with the drills. This increased productivity following the intervention is supported by a study done by Lehtonen et al, who found that productivity increased when there is a reduction in slack time and length of surgeries.[11] Another study by Abouleish made similar observations.[12]

The significant reduction in the operative time when the battery-powered drills were used can be attributed to the efficiency that invariably led to efficiency in the surgical process. This study did not directly study the cost implication of prolonged surgical operative time. However, studies done by Farnworth et al and Hosler et al showed that prolonged time on table significantly increased the cost to patients.[13,14] Authors can, therefore infer that the reduction in the surgical operative time following the intervention led to cost reduction to the patient.

In many countries, prolonged waiting times in the provision of health care has become an important health policy.[15,16] It has been linked to inefficiencies in the health system, public disaffection and prolonged suffering of patients.[17,18] Imbalances between demand and supply have been cited as the reason why patients wait. If demand outweighs supply, queues form and hence patients wait.[19]

The results suggested that the use of the battery-powered drills led to a significant reduction in the average waiting time and there was also a strong positive correlation (Table 4). This is true as more cases could be done daily with the availability of these drills. Waiting times for conditions such as external fixations and physeal injuries from January 2012 to December 2014 were almost same as they were emergencies and every effort was made to have the surgeries done as such (Table 3).

The differences in waiting times for the other procedures were because of demand for surgery exceeding the rate at which the surgeries were done. The main limitation at this point was the manual hand drills as they were less efficient. This is supported by Taylor HR.[20]

He indicated that for a procedure, the waiting time difference depends on the difference in indication or clinical threshold for when the procedure was done.

The strength of this study is that it contributes to the body of knowledge as there is limited data on auditing of the impact powered drills have on the efficient running of orthopedic and trauma process in LMICs, especially in sub-Saharan Africa. The implication is that, hospitals and health authorities may see the need to invest in these resources for efficient running of health facilities especially those that see and manage orthopedic trauma cases.

The study may not be generalizable to developed countries, as the problems encountered in LMICs may not be applicable in such populations. Other limitations were the small sample size and the retrospective nature of the study.

CONCLUSION

The introduction of the battery powered drills led to significant improvement in the total number of cases done, time spent per case in the operating room and the average waiting time to have surgery were reduced significantly.

Therefore, the understanding of the impact resources makes and in this case battery-powered drills on the efficient management of orthopedic patients should lead to allocation of more resources to such areas.

Authors strongly recommend the use of these battery powered orthopedic drills in LMICs especially in sub-Saharan Africa. This, in turn, authors believe, will lead to significant improvement in the health care delivery system.

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