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# Orthopaedic Surgical Task-Shifting and Its Impact on Time-to-Surgery in Western Uganda

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**Abstract:** Background: High rates of orthopaedic injury in Uganda place large burdens on its few orthopaedic surgeons. Although "task-shifting" of procedures to other providers is practiced, its specific role in orthopaedic surgical care is not well documented. The current study assessed the prevalence of orthopaedic task-shifting, and its impact on time-to-surgery, at the Mbarara Regional Referral Hospital (MRRH) in Western Uganda. Methods: A retrospective cohort study was conducted. All orthopaedic cases recorded in the MRRH operating theatre logbook were analyzed (October 2018 to July 2019). Surgical indication, type of procedure, and operator were recorded. Permanent hospital records, when available, were used to verify logbook data and identify the initial date of hospital admission for each patient. Results: There were 203 patients who received orthopaedic surgery during the study period, with 159 having hospital admission dates. The single orthopaedist at MRRH performed the majority of orthopaedic procedures (61.6% of cases). Significant task-shifting was seen, both to other physicians (33% of cases) and orthopedic clinical officers (5.4%). The orthopaedist performed most hardware implantation procedures (80.8%), while other practitioners performed the majority of trauma cases, particularly conservative fracture management (92.7%). Overall, the average time from admission to surgery was longer for orthopaedists (11.2 days) than for other providers (4.2 days, $p<0.001$). Conclusions: The current study demonstrates high utilization of orthopaedic task-shifting, and its associated decreased time-to-surgery, at MRRH. This reinforces the role of task-shifting in resource-limited settings. Furthermore, it highlights the importance of continued training of non-orthopaedic providers in foundational orthopaedic surgical principles.

**Keywords:** Global Surgery, Orthopedics, Outcomes, Rural, Trauma

## 1. Introduction

Injury is a leading cause of morbidity and mortality, accounting for 6 of the 15 leading causes of death in adolescence to middle-age worldwide [1]. Injury is disproportionately high in low and middle-income countries (LMICs), largely due to high rates of road traffic injury (RTI) [2]. This may be attributed to a variety of factors such as high levels of urbanization, poor infrastructure, passenger overload, lack of training/licensing, limited regulation, and weak law enforcement [3]. In Uganda, RTI is especially prevalent among those who use motorcycles, colloquially called "boda-bodas", the most common form of local public transportation [4, 5].

The demand for orthopaedic care in Uganda is high. Injury-related care accounts for over 60% of the surgical budget of Mulago Hospital, Uganda's largest hospital [4]. Nonetheless, access to trained orthopaedic surgeons is limited throughout Uganda [2]. In order to mitigate the demand for their services, orthopaedists often share their surgical load with other surgeons, such as general surgery residents. Additionally, orthopaedists are often assisted by orthopaedic clinical officers (OCOs), who attend 3 years of post-secondary school and 2 years of internship. This model of delegating

tasks to less-specialized providers has been defined as "task-shifting" by the WHO [6, 7]. Task-shifting has been shown to effectively increase surgical capacity in LMICs. For example, a recent study in Malawi found that OCOs performed nearly half of the major orthopaedic procedures with results similar to that of trained surgeons [8, 9].

Task-shifting has been implemented in Uganda for decades. For example, OCOs have been important in scaling-up clubfoot treatment country-wide [10]. However, there is limited data related to task-shifting for surgical procedures, particularly orthopedic procedures, in Uganda. This has been cited as a possible barrier to its expansion [11, 12]. The current study assessed the prevalence of orthopaedic task-shifting, and its impact on time-to-surgery, between orthopaedists and non-orthopaedists at the Mbarara Regional Referral Hospital (MRRH), a government-owned teaching and referral hospital in Western Uganda. Approximately 270 km from Kampala, MRRH serves six districts in Uganda's Western region with a population of 8 million, with one consultant orthopaedic surgeon of staff. It is hypothesized that time to surgery is lower for procedures performed by non-orthopaedists compared to those performed by the orthopaedic surgeon.

# 2. Material and Methods

A retrospective cohort study was conducted at MRRH from July-August 2019. All orthopaedic cases recorded in the MRRH operating theatre logbook, which contained cases from October 2018 to July 2019, were analyzed. Surgical indication, type of procedure, and operator were recorded.

When available, permanent hospital records, which are housed as physical copies within the hospital record library, were used to verify logbook data and identify the initial date of hospital admission for each patient. Time-to-surgery analyses included only those patients who had verifiable permanent hospital records. Patients admitted to the hospital for over two months were also excluded.

Data were analyzed based on procedure type, time-to-surgery, and provider specialty, including orthopaedist, non-orthopaedist, or OCO. Non-orthopaedists included any surgeon who was not an orthopaedic surgeon, the majority of which were general surgery residents. Furthermore, data were organized into four major categories: traumatic injury, which included operative injury management (OIM) and non-operative injury management (NOIM), infection, malignancy, and general orthopaedic problems. OIM included operations performed to definitively manage the injury. This did not include debridement followed by closed reduction and casting.

Statistical analyses were performed with Prism 8 (GraphPad Software Inc., San Diego, CA). Welch's t-test was used for quantitative comparisons with significance set at $p<0.05$.

# 3. Results

### *3.1. Orthopaedic Conditions Undergoing Surgery at MRRH*

There were 203 patients who received orthopaedic surgery during the study period. Traumatic injury was the most common reason for surgery (81.8% of total cases), with the lower limb implicated in 80.8% of cases. Infection was the second-most-common reason for surgery (19%), which included wound infections, osteomyelitis, and necrotic etiologies (gangrene, necrotizing fasciitis, etc.). There were 4 cases of tendinopathy, 4 cases of musculoskeletal tumor, 2 orthopedic conditions of unspecified etiology undergoing surgical intervention (i.e. elbow fusion, genu valgum), and one foreign body removal (nail). A summary of the orthopaedic conditions treated surgically can be seen in Figure 1.

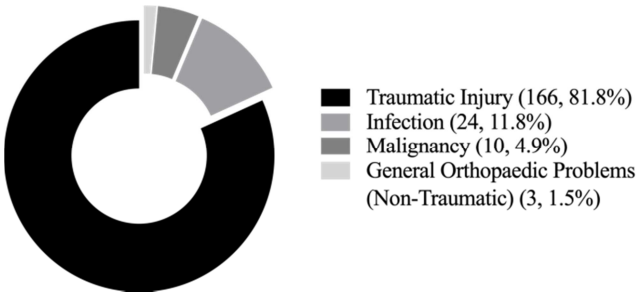


***Figure 1.*** *Types of Orthopaedic Conditions Receiving Surgical Treatment at MRRH.*

***Table 1.*** *Analysis of Orthopaedic Procedures at MRRH.*

| Procedure | Total | Orthopaedic Surgeon (OS) | Non-OS | OCO | Performed by OS (%) |
|---|---|---|---|---|---|
| All Traumatic Injury | 166 | 104 | 53 | 9 | 62.7 |
| Operative Injury Management | 125 | 101 | 16 | 8 | 80.8 |
| Debridement + External Fixation | 11 | 2 | 2 | 7 | 18.2 |
| Debridement + Internal Fixation | 2 | 2 | 0 | 0 | 100.0 |
| External Fixation | 22 | 20 | 2 | 0 | 90.9 |
| Internal Fixation or Arthroplasty | 68 | 67 | 1 | 0 | 98.5 |
| Other* | 22 | 10 | 11 | 1 | 45.5 |
| Non-Operative Injury Management | 41 | 3 | 37 | 1 | 7.3 |
| Closed Reduction | 4 | 3 | 0 | 1 | 75.0 |
| Debridement + Closed Reduction | 37 | 0 | 37 | 0 | 0.0 |
| Infection | 24 | 11 | 13 | 0 | 45.8 |
| Amputation | 9 | 1 | 8 | 0 | 11.1 |
| Excisional Biopsy | 1 | 1 | 0 | 0 | 100.0 |
| Sequestrectomy | 9 | 9 | 0 | 0 | 100.0 |

| Procedure | Total | Orthopaedic Surgeon (OS) | Non-OS | OCO | Performed by OS (%) |
|---|---|---|---|---|---|
| Soft Tissue Debridement | 5 | 0 | 5 | 0 | 0.0 |
| Malignancy | 10 | 7 | 1 | 2 | 70.0 |
| Amputations | 2 | 2 | 0 | 0 | 100.0 |
| Biopsy | 4 | 1 | 1 | 2 | 25.0 |
| Excisions | 2 | 2 | 0 | 0 | 100.0 |
| Tumor Management | 2 | 2 | 0 | 0 | 100.0 |
| General Orthopaedic Problems (Non-Traumatic)** | 3 | 3 | 0 | 0 | 100.0 |
| Overall | 203 | 125 | 67 | 11 | 61.6 |

All orthopaedic operations recorded in the operating theatre logbook were separated based on the indication for surgery and the operating surgeon. Orthopaedists, non-orthopaedists, and OCOs all performed orthopaedic surgical procedures.
*Includes: open reduction of dislocation, fasciotomy, skin grafting, hardware removal, foreign body removal, amputations in the setting of trauma (including proximal femoral resection), tendon repair, and other non-specific procedures.
**Management for unspecified joint/tendon pathology

### *3.2. Surgical Task-Shifting for Orthopaedic Procedures at MRRH*

The majority of orthopaedic procedures at MRRH were performed by the orthopaedic surgeon (125 procedures, 61.6% of total). Non-orthopaedists—primarily general surgery residents—performed 67 (33.0%) and OCOs performed 11 (5.4%) of the total procedures.

Although the orthopaedist managed the majority of traumatic injuries (62.7%), differences in task-shifting were seen between operative and non-operative (conservative) management. For OIM, the orthopaedist performed the majority of cases (101 cases, 80.8% of total), followed by non-orthopaedists (16, 12.8%) and OCOs (8, 6.4%). OIM with internal fixation or arthroplasty was the most common procedure (68, 33.5%), performed almost entirely by the orthopaedist (67, 98.5%). OIM with external fixation was the second most common procedure (22, 10.8%), also predominantly performed by the orthopaedist (90.9%), although 2 (9.1%) cases were performed by non-orthopaedists.

In contrast, non-orthopaedists performed the majority of NOIM, performing all cases of debridement followed by closed reduction (37 procedures, 90.2% of total). Overall, among 55 debridements performed in all categories of orthopaedic procedures, only 4 (7.2%) were performed by the orthopaedist. These 4 debridements were all performed as part of definitive OIM with internal fixation; all other debridements were performed by non-orthopaedists. There was one dislocation treated with closed reduction in the operating theatre by an OCO.

***Table 2.*** *Average Time (In Days) From Admission to Orthopaedic Procedure at MRHH.*

| Procedure | Total Number of Procedures | Average number of days to surgery | | | |
|---|---|---|---|---|---|
| | | Orthopaedic Surgeon (OS) | Non-OS | OCO | All Providers (Mean) |
| All Traumatic Injury | 132 | | | | |
| Operative Injury Management | 106 | | | | |
| Debridement + External Fixation | 11 | 11.5 | 4.0 | 4.7 | 5.8 |
| Debridement + Internal Fixation | 2 | 4.0 | - | - | 4.0 |
| External Fixation | 20 | 12.7 | 11.0 | - | 12.7 |
| Internal Fixation or Arthroplasty | 58 | 11.7 | 13.0 | - | 11.7 |
| Other* | 15 | 13.8 | 5.3 | - | 8.9 |
| Non-operative Injury Management | 26 | | | | |
| Closed Reduction | 1 | - | - | 1.0 | 1.0 |
| Debridement + Closed Reduction | 25 | - | 1.4 | - | 1.4 |
| Infection | 19 | | | | |
| Amputation | 8 | 4 | 13.9 | - | 12.6 |
| Sequestrectomy | 6 | 10.5 | - | - | 10.5 |
| Soft Tissue Debridement | 5 | - | 4.3 | - | 4.3 |
| Malignancy | 5 | | | | |
| Biopsy | 3 | 1.0 | 9.0 | 10.0 | 6.7 |
| Excisions | 1 | 1.0 | - | - | 1.0 |
| Tumor Management | 1 | 1.0 | - | - | 1.0 |
| General Orthopaedic Problems (Non-Traumatic)** | 3 | 3.7 | - | - | 3.7 |
| Overall | 159 | 11.2 | 4.7 | 4.9 | 8.8 |

Dates of admission were collected from surgical patients who had verifiable hospital inpatient records. Surgeries occurring more than two months after admission were not included in calculations. Significant delays from time of admission to surgery are seen in all patient subgroups.
*Includes: open reduction of dislocation, fasciotomy, skin grafting, hardware removal, foreign body removal, amputations in the setting of trauma (including proximal femoral resection), tendon repair, and other non-specific procedures.
**Management for unspecified joint/tendon pathology

Surgical treatment for infectious etiologies was most commonly performed by non-orthopaedists (13 cases, 54.2% of total). There were 10 cases involving malignancy, 7 of which were performed by the orthopaedist. There were 3 procedures for unspecified joint/tendon pathology, grouped under general orthopaedic problems, all of which were performed by the orthopaedist.

### *3.3. Time-To-Surgery Following Hospital Admission (Days)*

There were 159 patients with hospital admission dates. The overall wait times for the orthopaedist, non-orthopaedists, and OCOs were 11.2, 4.7, and 4.9 days, respectively. The average overall wait time for total procedures was 8.8 days. Two patients were excluded from analyses due to being admitted for over 2 months. These included a patient admitted for 4 months with a femur fracture managed with proximal femoral resection and a patient with pyomyositis treated 71 days after admission with incision and drainage.

Of these 159 patients, OIM with hardware implantation was the most common procedure performed with an average wait time of 11.7 days (Table 2). Longest wait times were associated with OIM with external fixation (12.7 days), the second-most-common procedure performed. Five out of the total 15 procedure categories had wait times over 10 days. NOIM had the shortest wait times, none of which were performed by the orthopaedist.

***Table 3.*** *Time-to-Surgery Comparison of the Orthopaedic Surgeon and Other Providers.*

| Procedure | Overall | Orthopaedic Surgeon (OS) | Non-OS/OCO | p Value |
|---|---|---|---|---|
| All Traumatic Injury | | | | |
| Number of Cases | 132 | 87 | 45 | |
| Average Days until Surgery | 8.9 | 11.9 | 3.2 | <0.001 |
| Operative Injury Management | | | | |
| Number of Cases | 106 | 87 | 19 | |
| Average Days until Surgery | 11.2 | 11.9 | 5.6 | <0.001 |
| Non-operative Injury Management | | | | |
| Number of Cases | 26 | 0 | 26 | |
| Average Days until Surgery | 1.4 | - | 1.4 | - |
| Infection | | | | |
| Number of Cases | 19 | 7 | 12 | |
| Average Days until Surgery | 10.1 | 9.6 | 10.4 | 0.89 |
| Malignancy | | | | |
| Number of Cases | 5 | 3 | 2 | |
| Average Days until Surgery | 4.4 | 1.0 | 9.5 | <0.001 |
| General Orthopaedic Problems (Non-Traumatic)* | | | | |
| Number of Cases | 3 | 3 | 0 | |
| Average Days until Surgery | 3.7 | 3.7 | - | - |
| Overall | | | | |
| Number of Cases | 159 | 100 | 59 | |
| Average Days until Surgery | 8.8 | 11.2 | 4.8 | <0.001 |

Treatment by orthopaedic surgeons was associated with an increased time-to-surgery overall and for all operative trauma patients. P<0.05 was significant.
*Management for unspecified joint/tendon pathology

Overall, average time from day of patient admission to surgery was longer for the orthopaedist (11.2 days) compared to other providers (4.8 days, p<0.001). This pattern was also seen among trauma patients (11.9 vs. 3.2 average days, p<0.001) and among all patients receiving any form of debridement (7.8 vs. 2.2 days, p=0.002). However, the orthopaedist had decreased time-to-surgery among patients with malignancy compared to other providers (1.0 vs 9.5 days, p<0.001).

## 4. Discussion

The large demand for orthopaedic care in LMICs, particularly for trauma-related care in RTA, has led to utilization of task-shifting for improved access to care. The current study, although representative of only one region of Uganda, better characterized the role of orthopaedic surgical task-shifting in the country. Improved understanding of task-shifting and its effect on time-to-surgery may aid in the development of policies and strategies for increasing appropriate access to orthopaedic care. As delays in trauma surgery have been linked to increased morbidity, mortality, and hospital length-of-stay, these strategies are important for optimizing patient outcomes [13].

As expected, the majority of demand for orthopaedic care in the current study was secondary to traumatic injury. The primary orthopaedic condition treated was fracture, most commonly of the lower limbs, followed by infection requiring wound debridement. Referral hospitals in Ghana and rural South Africa have also reported that treatment of traumatic injuries represents the majority of their annual surgical caseloads, with rates as high as 95% [14]. These findings are not surprising, as traumatic injury secondary to motor vehicle accidents represents the largest contributor to global morbidity, mortality, and orthopaedic need [14, 15]. As such, the treatment of open fracture constitutes one of the three cardinal Bellwether Procedures for Essential Surgical Care [15].

Surgical task-shifting is a proposed strategy for overcoming this large trauma burden. The current study demonstrates high utilization of surgical task-shifting to both other surgeons, mainly general surgery residents, and OCOs at MRRH. The orthopaedist completed only 61.6% of all orthopaedic cases. Furthermore, procedures performed by other providers were associated with a significantly decreased time-to-surgery. This redistribution of specialized care amongst providers demonstrates a potentially viable answer to the staffing limitations associated with the scarcity of orthopaedic surgeons in Uganda. Such task-shifting has been effective in other African countries, particularly with respect to HIV care [7]. Despite concerns regarding the technical nature of surgery, African countries including Malawi, Tanzania, and Zambia have introduced surgical certified nurse practitioners into the medical workforce through initiatives supported by their respective Ministries of Health [8]. Studies have found that outcomes of procedures performed by this specialized workforce are similar to those performed by trained orthopaedists [16].

The current study suggests the value, yet limited scope, of task-shifting in Uganda. While task-shifters performed a large majority of NOIM, such as closed reductions and debridements, the orthopaedist still performed nearly all of the procedures involving internal fixation, especially those with intramedullary nailing or arthroplasty. Thus, while increased task-shifting may play a role in decreasing delays in debridement or definitive closed treatment, it likely would not decrease delays for definitive open treatment or more complex cases. In the current study, average wait times for patients requiring either internal or external fixation exceeded 10 days. In comparison, guidelines for femur fracture stabilization recommend treatment within 24 hours of the inciting event, with early treatment linked to decreased risk of thromboembolism and pulmonary complications, as well as decreased hospital length-of-stay [17]. This highlights the importance of continued efforts to increase the orthopedic surgical capacity in Uganda, including the number of skilled orthopedists. Among other initiatives, this may be accomplished by increasing the number of orthopedic training programs within the country and improving professional incentives and workforce conditions for trainees [18]. Improved incentives, such as access to specialist education, may also decrease "brain drain" within Uganda and the emigration rate of locally trained surgeons [19]. Novel methods of improving the effectiveness of orthopedic care by non-orthopaedists such as a WhatsApp referral group may help to improve orthopedic knowledge among non-orthopaedists and decrease treatment delays caused by the need to refer patients to specialists at higher-level facilities [20].

Several other factors besides surgical capacity contribute significantly to orthopedic treatment delays in Uganda. Shortages of anesthesiologists are comparable to those described for orthopaedists [21]. At MRRH, it is not uncommon for surgeries to be cancelled or delayed due to anesthesiology personnel or equipment shortages, even when an operating theatre and surgeon are available. As a result, surgeons at MRRH are only allowed to schedule cases 2 days a week. Furthermore, surgical supplies and equipment necessary for orthopaedic procedures are often scarce. When available, these supplies are often not commensurate with the needs of the communities, especially at primary referral centers such as MRRH [5]. Delays in treatment are also often related to the inability of patients to finance their surgeries. Although Uganda has a free national healthcare system, medical device and implant shortages and supply chain deficiencies often force patients to purchase their own orthopaedic hardware and implants for definitive treatment [22]. In some cases, patients and/or their families may spend several days raising money—often borrowing money or even selling personal possessions—in order to finance their [23]. These pressures often leave patients frustrated with the healthcare system and has led to many seeking alternative modes of healing, such as the use of traditional "bone setters", who contribute to higher rates of orthopaedic complications [24].

The current study has several limitations. Descriptive procedural data recorded in the operating theatre registry are limited, such that a case may be registered as "ORIF" for an open fracture without explicitly listing "debridement," though one may infer that it was done. Analyses were conducted using only what was specifically described. Additionally, time-to-surgery analyses were conducted only for those who had verifiable time courses between admission and surgery, which limited the dataset. Furthermore, time of admission does not indicate the time of onset of injury or other condition, which is unknown from the available data. With the available data, time course could be measured by days only. This led to some accepted inaccuracy: 12 hours would be counted as 1 day if the date of surgery was the next calendar day after the day of admission.

It is uncertain why some analogous procedures were performed by different operators (e.g. debridement and external fixation). It is possible that there was complexity or patient comorbidity that required waiting for the orthopaedist in some cases. In the current study, procedure type does not account for complexity or severity of the condition being treated. Reason for delay between admission and surgery is also not described, it is uncertain if provider availability was the driving force behind a longer time-to-surgery. Other delays could include resource availability or processing. Additionally, it is possible that a shorter time-to-surgery, such as for the general orthopaedic procedures, reflects elective scheduling rather than availability of resources. Furthermore, the current study may contain a seasonality bias based on seasonal patterns of orthopaedic disease or of personnel availability. Finally, it is not in the scope of this study to compare outcomes by provider type. These outcomes are not obtainable from the data sources used in this study. Though retrospective in nature, operating room logbooks, specifically from this hospital, have been shown to be accurate at measuring surgical case volume [25].

# 5. Conclusion

In conclusion, the current study demonstrated a high amount of surgical task-shifting at MRRH, with non-orthopaedists and OCOs performing a large number of orthopaedic procedures, such as wound debridement, immobilization, amputation, and even external fixation. Utilization of these providers was associated with a decreased time-to-surgery among orthopaedic patients. These data highlight the importance of training general surgeons and OCOs in basic orthopaedic surgical principles and management, as task-shifting to these providers can decrease burden on surgeons and improve time-to-surgery. Additionally, increased funding for orthopaedic training programs and recruitment of certified orthopaedic surgeons outside of major urban settings remains necessary.

# List of Abbreviations:

LMIC: low and middle-income country
MRRH: Mbarara Regional Referral Hospital
NOIM: non-operative injury management
OCO: orthopaedic clinical officer
OIM: operative injury management
OS: orthopaedic surgeon
RTI: road traffic injury

# Declarations

### *Conflicts of Interest/Competing Interests*

The authors have no relevant financial or non-financial interests to disclose.

### *Availability of Data and Materials*

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

### *Author's Contributions*

DK supervised project. MF and CP collected data. MF, CP, and AS analyzed and interpreted patient data. MF and CP created tables and figures. MF, CP, AS, MA, and KY helped in the writing of the manuscript. All authors read and approved of the final manuscript.

### *Consent to Participate*

Consent to participate was obtained from all participants included in the study.

### *Consent to Publish*

Consent to publish was obtained from all participants included in the study.

### *Informed Consent*

Informed consent was obtained from all participants included in the study.

### *Ethics Approval*

This study was approved by both the Yale Institutional Review Board and the Mbarara University of Science and Technology Research Ethics Committee prior to data collection. Furthermore, we certify that this study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

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