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Original research

Development of a ratio of emergent to total hernia repairs as a surgical capacity metric

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HIGHLIGHTS

- Data on hernia repairs are easy to obtain in a developing country.
- The ratio of emergent to total hernias correlates to a nation's health care spending.
- This correlation was found across all world bank income levels.

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ABSTRACT

Introduction. Non-communicable diseases including surgical conditions are gaining attention in developing countries. Despite this there are few metrics for surgical capacity. We hypothesized that (a) the ratio of emergent to total hernia repairs (E/TH) would correlate with per capita health care expenditures for any given country, and (b) the E/TH is easy to obtain in resource-poor settings. **Methods**. We performed a systematic review to identify the E/TH for as many countries as possible (Prospero registry CRD42013004645). We screened 1285 English language publications since 1990; 23 met inclusion criteria. Primary data was also collected from Kamuzu Central Hospital (KCH) in Lilongwe, Malawi. A total of 13 countries were represented. Regression analysis was used to determine the correlation between per capita health care spending and the E/TH. **Results**. There is a strong correlation between the log values of the ratio emergent to total groin hernias and the per capita health care spending that is robust across country income levels ($R^2 = 0.823$). Primary data from KCH was easily obtained and demonstrated a similar correlation. **Conclusions**. The ratio of emergent to total groin hernias is a potential measure of surgical capacity using data that is easily attainable. Further studies should validate this metric against other accepted health care capacity indicators.

Systematic review registered with Prospero (CRD42013004645).

1. Introduction

Non-communicable diseases are gaining more attention as a cause of morbidity and mortality in developing countries [1]. Surgical conditions are included in this category, as they disproportionately affect low-income countries [2]. Basic surgical services are also traditionally viewed as prohibitively expensive, but in reality considerable evidence suggests that improving surgical care may result in significant gains in health with minimal expense [3].

Surgical care in low and middle income countries (LMIC) continues to gain attention from the developed world [4]. There is a consensus that we have yet to resolve the critical shortcoming of surgical capacity in LMICs [5]. Despite this, there are few metrics available to quantify surgical capacity. We broadly defined the construct of surgical capacity as the ability of a health care system to meet the needs of its population. With the exception of injury, the commonly accepted national health indicators fail to provide assessments of surgical capacity. The World Health Organization (WHO) global health indicators typically report many variables pertinent to overall health (such as life expectancy and mortality, health expenditure, and demographic and socioeconomic statistics), infectious diseases (selected infectious diseases such as HIV/

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AIDS, tuberculosis and diarrheal diseases), infant and early childhood mortality and women's health (for example family planning, antenatal care coverage and maternal mortality) [6].

Despite the failure to include measures of surgical disease related morbidity and mortality in the WHO global health indicators, there are several published methods of assessing surgical capacity. Some proposed approaches involve many variables such as the Personnel, Infrastructure, Procedures, Equipment, and Supplies (PIPES) tool and the WHO Emergency and Essential Surgical Care (EESC) assessment tool [7,8]. The most studied single metric, the ratio of Cesarean deliveries to total surgical cases (C/O), was proposed as a simple proxy for assessing surgical capacity. Several studies validate this ratio: developed countries have a lower C/O ratio compared to developing countries [9]; in Haiti the C/O ratio decreased as surgical capacity increased [10]. Though the C/O ratio appears to reflect surgical capacity it has several limitations including confounding by differences between countries in both birth rate and Cesarean section rates as a proportion of total births [11]. Some providers perform both obstetric and general surgical care, especially at rural or district hospital settings. In these settings the C/O ratio will function well. However, there are additional limitations of such a hybrid indicator. First, development leads to further specialization making specialty- or disease-specific indicators more useful. Second, interventions specific to either obstetrics or to general surgery will be difficult to measure using the C/O ratio.

We sought to identify a method of assessing surgical capacity. Worldwide the commonest general surgical condition is that of groin hernias (inguinal and femoral hernias). Procedures for groin hernias are common at Kamuzu Central Hospital (KCH), where the co-authors participate in a surgical partnership between KCH and the University of North Carolina. The co-authors also noted a surprisingly high rate of emergent procedures for groin hernias, which further prompted interest in groin hernias as a metric for surgical capacity. We hypothesized that Malawi would have a high ratio of emergent to total hernia repairs (E/TH), and that across countries E/TH would correlated with common health statistics. Therefore the aims of this paper were to (a) describe the prevalence of elective and emergent surgery for hernias at KCH, and (b) evaluate E/TH as a metric for surgical capacity by comparing the E/TH for Malawi and other countries to per capita health care spending.

2. Methods

The surgical log for Kamuzu Central Hospital during the calendar year 2009 was reviewed. Kamuzu Central Hospital is a 1000 bed government hospital that is a tertiary referral center for about 5 million persons. The hospital has 4 major operating rooms, and the Surgery Department annually has about 4500 admissions and performs around 2000 cases. Among adults (age 16 or older), descriptive statistics were calculated for the total number of cases and the number of elective and emergent groin hernia cases. Cases were also classified as primary or recurrent, direct or indirect, femoral or inguinal, and by affected side.

Our systematic review utilized PubMed searching for English language studies published between 1990 and 2013 using the term “emergency hernia”. Publications reporting results of randomized controlled trials, those limited to pediatric or elderly populations, and those limited to femoral or incisional hernias were excluded, first using title only ($N = 1246$), with the remaining then reviewed in full text (excluding an additional 23 studies). The reference lists of those meeting criteria after full text review were then checked to identify any additional studies. Data was abstracted and checked by two authors. If multiple publications were found for one country, values were averaged. The ratio was selected based on the following priority: groin hernias (femoral and inguinal hernias), inguinal hernias and lastly, external hernias (femoral, inguinal and ventral hernias). Some but not all studies included recurrent hernias, thus to minimize this source of heterogeneity we limited our analysis to non-recurrent hernias. The protocol for this systematic review was registered with Prospero (registered on 20 May 2013; CRD42013004645).

For each country, E/TH was compared to country-wide economic and health indicators (per capita expenditures on health care and World Bank country income level). Per capita expenditures on health care were expressed in 2009 US dollars. World bank country income levels (per capita gross national income) were expressed as low-income country (LIC; less than $4035), Low middle-income country (L-MIC; $4036–$4085), high middle-income country (H-MIC; $4086–$12,615) and high-income country (HIC; greater than $12,615) [12]. The R^2 correlation statistic was used to calculate the correlation between the actual and the log values for per capita health care expenditure and E/TH for each country. Analysis of dependent variable residual plots was used to identify the model with the least heteroscedasticity.

Ethics approval for the analysis of data from Malawi was obtained from the Institutional Review Board at the University of North Carolina and the National Health Sciences Review Committee of Malawi.

3. Results

In 2009, there were 219 adult groin hernia surgeries performed at Kamuzu Central Hospital in Lilongwe, Malawi. Of these, 88 were emergent. The total number of operations during the study period was 1956. Of the 219 groin hernias, 212 were indirect inguinal hernias, five were femoral hernias, and two were direct inguinal hernias. There were four recurrent hernias, and all five of the femoral hernias were operated on emergently. Of the indirect inguinal hernias, 123 were right-sided, 62 left-sided, seven bilateral, and 25 unspecified.

The initial search in Pubmed between 1990 and 2013 using the term “emergency hernia” identified 1285 publications. Initial screening for exclusion utilizing only titles excluded 1246 publications, and of the remaining 39 the full text was reviewed and an additional 23 were excluded. Sixteen publications thus met criteria, and after reviewing the reference lists of these 16 studies, an additional seven studies were identified. The total number of publications included was therefore 23 (Fig. 1; Table 1) [13–35].

After averaging data from publications from the same country and inclusion of the primary data from Malawi, 13 countries were included in the analysis, including four LICs (Malawi, Sierra Leone, Tanzania and Uganda), two L-MICs (Ghana and Nigeria), two H-MICs (Malaysia and Turkey) and five HICs (Denmark, Italy, Sweden, United Kingdom and United States) (Table 2). Most hernias included in this analysis were inguinal; in studies reporting other types of hernias, these represented a minority of patients (femoral, 0.1%–8%; ventral, 3–11%).

The log–log regression of emergent to total hernias and per capita expenditure on health care revealed a strong correlation (R^2 0.823, Fig. 2). A plot of the absolute value of dependent variable (emergent to total hernia ratio) residuals revealed that heteroscedasticity was minimized by using the log–log relationship rather than actual (non-transformed) values or actual-log values (data not shown).

4. Discussion

Our results suggest that the E/TH represents a potential health indicator for surgical capacity. This proposed indicator is robust in