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## Original research

Influence of sub-specialty surgical care on outcomes for pediatric emergency general surgery patients in a low-middle income country<sup>☆</sup>

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## HIGHLIGHTS

- Adult-managed patients had higher complications (OR [95%CI]: 5.42 [2.10–14.00]).
- Adult-managed patients had longer average LOS (7.98 vs. 5.61 days,  $p < 0.01$ ).
- 39.8% fewer complications expected if all patients managed by pediatric surgery.
- An 8.2% decrease in LOS expected if all patients managed by pediatric surgery.
- Resources needed for pediatric surgery parallel to adult general surgery teams.

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## ABSTRACT

**Background:** Whether adult general surgeons should handle pediatric emergencies is controversial. In many resource-limited settings, pediatric surgeons are not available. The study examined differences in surgical outcomes among children/adolescents managed by pediatric and adult general surgery teams for emergency general surgical (EGS) conditions at a university-hospital in South Asia.

**Methods:** Pediatric patients (<18y) admitted with an EGS diagnosis (March 2009–April 2014) were included. Patients were dichotomized by adult vs. pediatric surgical management team. Outcome measures included: length of stay (LOS), mortality, and occurrence of  $\geq 1$  complication(s). Descriptive statistics and multivariable regression analyses with propensity scores to account for potential confounding were used to compare outcomes between the two groups. Quasi-experimental counterfactual models further examined hypothetical outcomes, assuming that all patients had been treated by pediatric surgeons.

**Results:** A total of 2323 patients were included. Average age was 7.1y ( $\pm 5.5$  SD); most patients were male (77.7%). 1958 (84.3%) were managed by pediatric surgery. The overall probability of developing a

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complication was 1.8%; 0.9% died (all adult general surgery). Patients managed by adult general surgery had higher risk-adjusted odds of developing complications (OR [95%CI]: 5.42 [2.10–14.00]) and longer average LOS (7.98 vs. 5.61 days,  $p < 0.01$ ). 39.8% fewer complications and an 8.2% decrease in LOS would have been expected if all patients had been managed by pediatric surgery.

**Conclusion:** Pediatric patients had better post-operative outcomes under pediatric surgical supervision, suggesting that, where possible in resource-constrained settings, resources should be allocated to promote development and staffing of pediatric surgical specialties parallel to adult general surgical teams.

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## 1. Introduction

Each year, an estimated 234 million surgeries are performed worldwide [1]. Conditions requiring emergency supervision form the majority of this case and patient load [2], representing as much as 10% of global deaths (32% more than the number of fatalities resulting from malaria, tuberculosis, and HIV/AIDS combined) [3]. Beyond its high prevalence, the global burden of surgical disease is disproportionately skewed in favor of high-income countries – a situation which leaves more than one-third of the world's population living in low- and middle-income countries (LMICs) to receive only 3% of surgical interventions [1]. Such a situation often translates into poorer access to operative interventions in resource-constrained settings.

Among pediatric populations for whom the global risk of injuries has been increasingly on the rise [4], lack of access to pediatric emergency expertise poses a significant concern. In many resource-limited settings, including provision of care in LMICs, pediatric surgeons are not available, placing the burden of responsibility for pediatric patients on providers trained to operate, primarily, on adults. Even among hospitals where pediatric specialists are available, it is not unusual for pediatric patients requiring urgent surgical attention to be transferred to ancillary facilities or seen by non-pediatric surgical providers. Whether or not general surgeons who specialize in the care of adult patients, in addition to pediatric surgical providers, should handle pediatric emergencies remains a controversial issue with implications ranging from uncertainty of outcomes among pediatric patients to interruptions in the continuity of care and delayed receipt of definitive treatment, as Osler et al. and Shah et al. have described [5,6].

In many South Asian countries, pediatric surgery is an emerging specialty [7]. Dedicated pediatric centers are uncommon, and the number of trained pediatric surgeons serving the expanding patient population is limited [7]. Delays in access to care are further common due to the absence of pre-hospital care and triage, meaning that children/adolescents with emergency conditions often get absorbed into adult surgical services when pediatric surgeons are absent or overwhelmed [8]. The problem, as noted by Sims and colleagues, is that pediatric and adult patients require different management techniques, particularly pediatric patients at the younger end of the pediatric age range [9]. Guidelines suggest that pediatric surgeons should always manage children less than 3–5 years of age [10–12].

An existing study of trauma outcomes in the United States dating back to 1998 showed a lack of significant difference in post-operative outcomes for children managed at adult vs. pediatric trauma centers [5,13,14]. It remains unclear whether EGS-specific data from a resource-constrained setting would yield similar results. The objective of the present study was to examine updated differences in surgical outcomes among children/adolescents managed by pediatric and adult general surgery teams for

emergency general surgery (EGS) conditions at a university-hospital in South Asia.

## 2. Methods

The study was conducted as a retrospective analysis, cohort study of all consecutive pediatric surgical patients (aged <18 years) treated at the Aga Khan University Hospital (AKUH) presenting with a primary diagnosis consistent with an EGS condition as defined by the American Association for the Surgery of Trauma (AAST) [15] between March 2009 and April 2014 (Fig. 1). Analysis was conducted in April 2015. The AKUH is a tertiary-level teaching facility comprised of 577 beds that serves an estimated population of 15.5 million people in the metropolitan city of Karachi, Pakistan [16–20]. It hosts an experienced in-house pediatric surgical faculty and an integrated pediatric surgical residency program. The section of pediatric surgery provides a wide range of diagnostic and therapeutic services in the management of surgical and urological problem in neonates and children. The pediatric hospital floor consists of 29 beds. The section of pediatric surgery is staffed by five in-house pediatric surgeons [21]. Pediatric patients presenting to the emergency department (ED) are managed by an on-call pediatric surgical resident. However, despite these resources, pediatric services often find themselves overwhelmed, forcing excess pediatric surgical admissions to be absorbed into the hospital's adult general surgery service – the details of which have been previously described [22,23].

Identification of EGS conditions was completed based on agreement with a uniform set of 621 International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) primary diagnosis codes defined by the AAST, including management of both operative and non-operative emergent conditions [2,15,24,25].

Data on patient demographic and clinical characteristics, including age (categorized as 0–5, 6–12, and 13–17 years), sex, ED admission, managing specialty (pediatric vs. adult general surgery), year, length of hospital stay in days, mortality, and ICD-9-CM diagnosis and procedure codes, were abstracted from AKUH administrative records by trained reviewers. Based on the diagnostic codes applied to each patient's admission, information on pre-existing conditions was determined via calculation of a corresponding Charlson Comorbidity Index (CCI) (categorized as 0, 1, 2, or  $\geq 3$ ) [26]. Presence of one or more post-operative complication(s) was also determined, including information on the occurrence of pneumonia, pulmonary emboli, urinary tract infections, cardiac arrests, renal failures, sepsis, and septic shock. Data on operative interventions and EGS diagnostic categories were obtained using available ICD-9-CM procedure and diagnostic codes. Postoperative outcome measures included the occurrence of one or more major complication(s), in-hospital length of stay (LOS), extended LOS (defined as LOS longer than the 75th percentile in a right-skewed distribution), and all-cause mortality.

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