Abstract

Background: In Nepal’s remote regions, challenging topography prevents patients with cleft lip and palate (CLP) from seeking care.

Objective: To measure the effect of a mobile surgical scout program on CLP surgical care in remote regions of Nepal.

Methods: Forty-four lay people were trained as mobile surgical scouts and over 5 months traversed remote districts of Nepal on foot to detect and refer CLP patients for surgical care. Surgical patients from remote districts were compared with matched time periods in the year before intervention. Diagnostic accuracy of the surgical scouts was assessed.

Findings: Mobile surgical scouts accurately diagnosed (90%) and referred (82%) patients for cleft surgery. Before the intervention, CLP surgeries from remote districts represented 3.5% of cleft surgeries performed. With mobile surgical scouting, patients from remote districts comprised 8.2% of all cleft surgeries ($p = 0.007$). When transportation and accompaniment was provided in addition to mobile surgical scouts, patients from remote districts represented 13.5% ($p \leq 0.001$) of all cleft surgeries.

Conclusion: Task-shifting the surgical screening process to trained scouts resulted in accurate diagnoses, referrals, and increased access to cleft surgery in remote districts of Nepal.

Introduction

The majority of the world’s population lacks access to surgical care.$^1$ Africa and Southeast Asia harbor a third of the world’s population, but only 12% of the world’s surgical specialist workforce.$^2$ A lack of surgeons in low- and middle-income countries (LMICs) drives highly centralized subspecialty surgery care models that are inaccessible to many.

Task-shifting has long been employed in LMICs to address the surgical workforce crisis.$^3$ Task-shifting delegates specific surgical responsibilities to nonspecialists,$^4$ whereas task-sharing refers to joint surgical responsibility with oversight. For procedures such as cesarean sections, this is proven to be safe and effective.$^4-6$ Cleft facial anomalies occur in $\sim 1$ in 700 births worldwide$^7$ and cleft care lies within the “essential surgery package”$^8$.

David A. Shaye, MD, MPH, FACS,$^{1,2,8}$ Kiran Kishor Nakarmi, MCh,$^3$ Pramila Shakya, MS,$^3$ Leeza Pradhan, MS,$^3$ Kabita Bhattarai, BN,$^3$ Badri Rayamajhi,$^3$ Hemanta Dhj Joshi,$^3$ Courtney M. Yuen, PhD,$^2$ Kailash Khaki Shrestha, MPH,$^3$ and Shankar Man Rai, MS$^3$
described by the Disease Control Priority Project 10. Although LMICs lack enough surgeons to address the cleft lip and palate (CLP) burden of disease,8–10 task-shifting cleft surgery may prove excessively complex. However, task-shifting the cleft surgical screening process is yet to be evaluated.

Nepal is a low-income country where the beautiful but challenging Himalayan terrain poses immense challenges to surgical access. Eighty percent of Nepal’s 31 million people reside in a rural setting.11 Although primary care is effectively decentralized, specialized surgery remains centralized and inaccessible. To address this, we task-shifted the CLP surgical screening process to lay people trained as mobile surgical scouts. We hypothesized that a mobile surgical scout program comprised of lay people would accurately diagnose and refer patients with CLP for surgery and, therefore, improve access to care in remote regions. We implemented such a program and prospectively studied its effectiveness.

Methods
A mobile surgical scout program to identify patients with unrepaired orofacial clefts was implemented in Nepal. Scouts were lay people who completed a 1-week training (Fig. 1), then spent 5 months on foot recruiting patients from remote districts. Scouts assessments were performed on (1) pre- versus post-training test results, (2) CLP diagnostic accuracy, and (3) surgical access for patients in remote regions.

Setting
Kirtipur Hospital (Nepal Cleft and Burn Center, Kathmandu) is a public–private partnership hospital that performs the majority of CLP surgery for Nepal in Kathmandu and at mobile surgical camps. Hospital records indicate that mountainous and geographically isolated districts demonstrate the fewest number of cleft surgeries per capita (Fig. 2). These 22 districts were selected for the intervention.

Surgical scout training and assessment
Forty-four surgical scouts underwent a 1-week training by cleft surgeons (Supplementary Video S1). Scouts were lay people with no medical background but familiar with the terrain of their corresponding remote district. Training focused on CLP diagnosis and appropriate referral. Standard cases were to be referred to mobile surgical camps. Higher acuity patients (e.g., airway concern, syndromes, and suspected cardiopulmonary conditions) were to be referred to Kirtipur Hospital in Kathmandu. Training, food, accommodation, and transportation were provided and scouts were paid a monthly stipend.

To assess scouts’ postcourse knowledge, testing was performed before and after the 1-week training period and compared using a paired t-test. To determine accuracy, scout diagnoses were compared against cleft surgeon diagnoses. Positive predictive value (PPV) of diagnosis was calculated as the number of correct diagnoses out of the total number of diagnoses.

Surgical scout intervention and assessment of impact
Forty-four surgical scouts traversed their assigned remote districts by foot, in pairs, over a 5-month period (March 1–August 1, 2017). Surgical scouts were familiar with the geography of their assigned remote district. At each village scouts performed community surgical screenings. Per the scouts’ decision, those with CLP without comorbidities were referred to a nearby mobile surgical camp for surgery, whereas those with CLP with comorbidities...
Fig 2. District map of Nepal. The 22 most remote districts (as denoted by yellow stars) that demonstrated the fewest number of cleft surgeries performed per capita. The districts are Rolpa, Rukum, Mustang, Manang, Darchula, Jumla, Humla, Kalikot, Dolpa, Mugu, Bajhang, Bajura, Achham, Dailekh, Jajarkot, Doti, Dadeldhura, Baitadi, Salyan, Rasuwa, Sankhuwasava, Solukhumbu. Red stars represent mobile surgical camps at established outreach hospitals where surgeries are performed. Pink star denotes Nepal Cleft and Burn Center in Kathmandu, Nepal.

Fig 3. Patients with cleft lip and palate in remote geographic regions of northern Nepal were assessed by mobile surgical scouts and referred for surgical care to either mobile surgical camps or a tertiary care center (Nepal Cleft and Burn Center, Kathmandu, Nepal). Decentralizing the surgical screening process improved access to subspecialized care for patients with cleft lip and palate in remote regions of Nepal only accessible by foot.
were referred to Kirtipur Hospital, Kathmandu for surgery (Fig. 3). Next, scouts again returned to their remote districts to perform surgical screenings and referrals for another 5-month period (August 1–December 1, 2018), however this time offered transportation and accompaniment assistance. All surgeries at all referral sites were performed by our fully trained cleft surgeons.

To assess the effectiveness of the intervention we compared the proportion of patients from the 22 remote districts who received cleft surgery to all patients throughout the country receiving cleft surgery. This was examined at baseline and across both intervention periods. A 12-month baseline period was retrospectively established between January and December 2016. A chi-squared test with a mid-$p$ exact $p$-value was used to compare the proportion of surgical patients from remote districts during each of the two intervention periods with the baseline year. Sensitivity analyses were performed to compare the March–August 2017 and August–December 2018 intervention periods to the corresponding months in 2018 to account for possible seasonal changes.

Ethical approval
Before conducting this prospective interventional study, ethical approval was obtained from the Nepal Health Research Council (Reg. No. 45L/20L6) and the Institutional Review Board of the Harvard Faculty of Medicine. Informed consent was obtained from patients during screening.

Results
Surgical scout training and assessment
The mean pretest scores of scouts on knowledge of cleft deformities was 48% (range 25–83%) and the mean post-test score was 74% (range 37–100%). Post-test scores were significantly higher than the pretest scores ($p \leq 0.001$). The overall PPV for scouts’ diagnoses of patients with cleft deformities was 89%, but this varied by condition. The PPV of scouts’ performance in diagnosis was 96% for cleft lip, 74% for cleft palate, and 95% for cleft lip with cleft palate (Table 1). Scouts correctly referred patients 82% of the time; 99 individuals with clefts were correctly referred to outreach centers and 29 correctly referred to Kathmandu, whereas 14 each were incorrectly referred.

Impact on access to surgical care
During the control period, 3.5% (24/682) of the patients who received cleft operations were from the 22 remote districts (Table 2). During the intervention period when scouts were evaluating and referring cleft patients (but not providing transport), 8.2% (19/233) of operated patients were from remote districts ($p = 0.007$ compared with baseline). During the time that accompaniment and transport was being provided in the remote districts, 13.5% (37/274) of all operated patients came from remote districts ($p < 0.001$ compared with baseline). In the interim time between these two intervention periods when scouts ceased all activity, 3.7% (21/557) of all operated patients came from remote districts, which was not significantly different from the baseline year ($p = 0.813$).

In the sensitivity analysis, the percentage of patients from remote districts during March to August 2017 (8.2%) was significantly higher than the percentage from remote districts during March to August 2016 (7/307, 2.3%, $p = 0.002$). The percentage of patients from remote districts during August to December 2018 (13.5%) was significantly higher than the percentage from remote districts during August to December 2016 (13/239, 5.4%, $p < 0.001$).

Discussion
Task-shifting of CLP care is an innovative way to increase access in LMICs. Cleft speech therapy, for example, has been effectively task-shifted in Nepal, yet there remain little data on the utility of task-shifting the surgical screening process. Lay people may offer unique opportunities to expand surgical access in LMICs. Highlighting this fact is that parents of patients with CLP, volunteers, and even electricity meter readers have been taught to identify and refer patients with CLP. In Nepal, training of lay people to become mobile surgical scouts was effective in knowledge transfer, accurate diagnoses, and referrals. The 1-week course led by surgeon

Table 1. Cleft conditions identified (n = 156) and correctly diagnosed (n = 139) by scouts

| Condition                  | Cleft patients | Correctly diagnosed | Positive predictive value (%) |
|----------------------------|----------------|---------------------|-------------------------------|
| Only cleft lip             | 58             | 55                  | 95                            |
| Only cleft palate          | 42             | 31                  | 74                            |
| Cleft lip and palate       | 56             | 53                  | 95                            |

| Table 2. Percentage of cleft surgeries from remote Nepal districts at (1) baseline, (2) with surgical scout intervention, and (3) with surgical scout, accompaniment, and transport |
|--------------------------------------------------------------------------------------------------------------------------|
| Period                  | Intervention in remote districts | Cleft surgeries from remote districts/total cleft surgeries | % of cleft surgical patients from remote districts | p-Value for comparison with baseline |
|-------------------------|----------------------------------|----------------------------------------------------------|--------------------------------------------------|-------------------------------------|
| January–December 2016   | None (baseline)                  | 24/682                                                   | 3.5%                                              | 0.813                               |
| March–August 2017       | Surgical scouts                  | 19/233                                                   | 8.2%                                              | 0.007                               |
| August–December 2018    | Surgical scouts, Accompaniment, Transport | 37/274                                             | 13.5%                                             | <0.001                              |


specialists transferred a basic level of knowledge to lay people, which proved effective in the downstream diagnosis and evaluation of patients.

As LMICs face a surgical workforce crisis, challenging geography and remote communities can be difficult settings to expand surgical access. New methods to confront the surgical disease burden are needed. Task-shifting/sharing permits a logical allocation of tasks across various skill levels of the health care workforce, to maximize both access and quality. Solutions such as task-shifting are required in a world where 5 billion people lack access to safe surgery and anesthesia. Rigorous evaluation of these solutions is of equal importance.

Diagnosis is the first step of treatment. Diagnosis was effectively task-shifted to mobile surgical scouts who proved capable of accurate diagnoses a majority (89%) of the time. Diagnostic accuracy for patients with cleft lip (96%) or a cleft lip with cleft palate (95%) were higher than diagnostic accuracy for those with isolated cleft palates (74%). Diagnosis of an isolated cleft palate poses the additional requirement of an intraoral examination. Task-shifted diagnostic capabilities offer further potential with the expansion of technology, such as increasing mobile phone penetration rates. 

At the time of this study, a decentralized cleft surgical program existed in Nepal. Cleft surgeons from Kathmandu traveled to designated mobile surgical camps, where regional patients undergo surgery at approved district hospitals. The mobile surgical scout program required that scouts refer patients to either mobile surgical camps or a tertiary center. This permitted healthy cleft patients to undergo surgery in proximity to their homes, decreasing transportation barriers and improving access, whereas higher acuity patients were directed to a tertiary setting. Mobile scouts relied on their knowledge of difficult airway, micrognathia, suspected cardiac issues, or syndromes to inform their referral decision. As hypothesized, surgical scouts made appropriate referrals a majority (82%) of the time. Other regions that have isolated populations may benefit from a task-shifted surgical screening process.

Surgical scouts significantly increased access for those in the most remote districts of Nepal. The 22 most remote districts of Nepal comprise 12% of Nepal’s population; however, at baseline these 22 remote districts represented only 3.5% of total cleft surgeries. During the mobile surgical scout intervention, cleft surgeries from patients within the remote districts increased significantly to 8.2% (p = 0.007). Active case finding in Nepal has been reported for mental disorders and tuberculosis, but this is the first to our knowledge for specialty surgical services. Other surgical subspecialties that rely on a centralized care structure may consider decentralizing the screening process to expand access. A more efficient alternative is to incorporate the scout training package into the standard curriculum of Community Health Workers (CHW), who have performed similar tasks for other diseases. The potential of the CHW in identifying surgical disease has room for growth. Mobile technology may offer opportunities to lower barriers to CHW education.

Transportation is a key barrier to surgical care worldwide and within Nepal. Often nonmedical costs such as transportation, food, and housing can be significant forces that hinder access even when care is free. Free transportation and accompaniment in addition to the mobile scout program further increased access to 13.5% (p ≤ 0.001). Despite free surgery and evaluation, confronting transportation barriers should be a key part of programs to improve surgical access. This study has limitations. A concurrent control group was not selected since matching districts with various differences in geography, population, poverty, and road access was challenging. This study also lacks the data for the sensitivity of scouts identifying cleft individuals in the community, since the number of all the individuals with cleft deformities in those remote districts is not known. Based on estimates of cleft prevalence rates in the remote districts using population (census) data, we estimate the mobile surgical scouting program did not access the majority of cleft patients in remote districts. The study methodology did not capture the patients that scouts failed to diagnose at the community level, since it was not feasible to have cleft surgeons also perform concurrent diagnosis in each community. Overall, task-shifting surgical screening to mobile surgical scouts significantly improved access to cleft surgery in remote districts in Nepal. Provision of free transport and accompaniment further increased access.

Conclusions

Lay persons trained as mobile surgical scouts increase access to cleft surgery for patients in rural Nepal. Mobile surgical scouts showed an improved knowledge base after a 1-week course, and accurately diagnosed patients with CLP a majority of the time. Furthermore, scouts appropriately referred patients to either higher or lower acuity settings a majority of the time. Providing transportation and accompaniment further improved access. Task-shifting the surgical screening process is a valuable method to improve surgical access in regions facing surgical workforce shortages and geographic barriers.

Authors’ Contributions
All authors have met the criteria for ICMJE:

1. substantial contributions to the conception or design of the study; or the acquisition, analysis, or interpretation of data for the study;
2. drafting the article or revising it critically for important intellectual content;
3. final approval of the version to be published; and
4. agreement to be accountable for all aspects of the study in ensuring that questions related to the accuracy or integrity of any part of the study are appropriately investigated and resolved.

**Author Disclosure Statement**
No conflicts of interests for any authors.

**Funding Information**
This research was supported by Harvard Medical School, Center for Global Health Delivery—Dubai. Video production performed by Pramila Shakya, MS and Jessica Ellis. Special thanks to ReSurge International and The Smile Train for funding of cleft surgeries.

**Supplementary Material**
Supplementary Video S1

**References**
1. Alkire BC, Raykar NP, Shrime MG, et al. Global access to surgical care: a modelling study. *Lancet Glob Heal* (Internet). 2015;3(6):e316–e323.
2. Holmer H, Shrine MG, Riesen JN, Meara JG, Hagander L. Towards closing the gap of the global surgeon, anaesthesiologist, and obstetrician workforce: thresholds and projections towards 2030. *Lancet*. 2015;385:540.
3. Meara JG, Leather AJ, Hagander L, et al. Global surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet*. 2015;386(9993):569–624.
4. Chu K, Rosspeel P, Giels P, et al. Surgical task shifting in Sub-Saharan Africa. *PLoS Med*. 2009;6(5):e1000078.
5. Kruk ME, Pereira C, Vaz F, Bergstrom S, Galea S. Economic evaluation of surgically trained assistant medical officers in performing major obstetric surgery in Mozambique. *BJOG*. 2007;114:1253–1260.
6. Chilopora G, Pereira C, Kamwendo F, et al. Postoperative outcome of caesarean sections and other major emergency obstetric surgery by clinical officers and medical officers in Malawi. *Hum Resour Health*. 2007;5:17.
7. Poenaru D. Getting the job done: analysis of the impact and effectiveness of the SmileTrain program in alleviating the global burden of cleft disease. *World J Surg*. 2013;37(7):1562–1570.
8. Debas HT, Gosselin R, McCord C, et al. Chapter 67 surgery. In: *Disease Control Priorities in Developing Countries*, 2nd ed. New York: Oxford University Press; 2006. p. 124560.
9. Semer NB, Sullivan SR, Meara JG. Plastic surgery and global health: how plastic surgery impacts the global burden of surgical disease. *J Plast Reconstr Aesthet Surg*. 2010;63(8):1244–1248.
10. Debas HT, Donkor P, Gawande A, et al., eds. *Disease Control Priorities: Essential Surgery*, 3rd ed., Vol. 1. World Bank; 2015. http://www.dcp-3.org/surgery (Accessed September 1, 2021).

11. World Bank. World Development Indicator, Rural population (% of total population). http://data.worldbank.org/indicator/SP.RUR.TOTL.ZS. Accessed March 26, 2020.
12. Lindeborg MM, Shakya P, Pradhan B, et al. A task-shifted speech therapy program for cleft palate patients in rural Nepal: evaluating impact and associated healthcare barriers. *Int J Pediatr Otorhinolaryngol*. 2020;134:110026.
13. Federspiel F, Mukhopadhyay S, Milsom PJ, Scott JW, Riesel JN, Meara JG. Global surgical, obstetric, and anesthetic task shifting: a systematic literature review. *Surgery*. 2018;164(3):553–558.
14. Center for Global Health Delivery-Dubai. Global surgery: towards equitable surgical systems. In: *Global Surgery: Towards Equitable Surgical Systems (Internet)*, Center for Global Health Delivery-Dubai; 2016. p. 28. http://ghd-dubai.hms.harvard.edu (Accessed September 1, 2021).
15. World Bank Data. http://data.worldbank.org/Indicator/IT.CEL.SETS.P2. Accessed December 20, 2019.
16. Jordans MJ, Kohrt BA, Luitel NP, Lund C, Kompore IH. Proactive community case-finding to facilitate treatment seeking for mental disorders, Nepal. *Bull World Health Org*. 2017;95(7):531–536.
17. Gurung SC, Dixit K, Rai B, et al. The role of active case finding in reducing patient incurred catastrophic costs for tuberculosis in Nepal. *Infect Dis Poverty*. 2019;8(1):99.
18. Woldie M, Feyissa GT, Admasu B, et al. Community health volunteers could help improve access to and use of essential health services by communities in LMICs: an umbrella review. *Health Policy Plan*. 2018;33(10):1126–1143.
19. O’Donovan J, Verkerk M, Winters N, Chadha S, Bhutta MF. The role of community health workers in addressing the global burden of ear disease and hearing loss: a systematic scoping review of the literature. *BMJ Glob Heal*. 2019;4:e001181.
20. Yao CA, Swanson J, Chanson D, et al. Barriers to reconstructive surgery in low- and middle-income countries: a cross-sectional study of 453 cleft lip and cleft palate patients in Vietnam. *Plast Reconstr Surg*. 2016;138(5):887e–895e.
21. Grimes CE, Bowman KG, Dodgion CM, Lavy CBD. Systematic review of barriers to surgical care in low-income and middle-income countries. *World J Surg*. 2011;35(5):941–950.
22. Swanson JW, Yao CA, Auslander A, et al. Patient barriers to accessing surgical cleft care in Vietnam: A multi-site, cross-sectional outcomes study, *World J Surg*. 2017;41(6):1435–1446.
23. Massenburg BB, Jenny HE, Salka S, Meara JG, Alonso N. Barriers to cleft lip and palate repair around the world. *J Craniofac Surg*. 2016;27(7):1741–1745.
24. Varela C, Young S, Mkandawire N, Groen R, Banza L, Viste A. Transportation Barriers to Access Health Care for Surgical Conditions in Malawi: A cross sectional nationwide household survey. *BMC Public Health*. 2019;19(1):264.
25. Varela C, Young S, Groen R, Banza L, Mkandawire NC, Viste A. Untreated surgical conditions in Malawi: a randomised cross-sectional nationwide household survey. *Malawi Med J*. 2017;29(3):231–236.
26. van Loenhout JA, Delbiso TD, Gupta S, et al. Barriers to surgical care in Nepal. *BMC Health Serv Res*. 2017;17(1):72.
27. Kowalewski M, Mujinja P, Jahn A. Can mothers afford maternal health care costs? User costs of maternity services in rural Tanzania. *Afr J Reprod Health*. 2002;6(1):65–73.