Secondary Overtriage of Trauma Patients to a Central Hospital in Malawi

Rebecca G. Maine[1,4] · Chifundo Kajombo[2] · Gift Mulima[2] · Jennifer Kincaid[3] · Laura Purcell[1] · Jared R. Gallaher[1] · Trista D. Reid[1] · Anthony G. Charles[1]

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Abstract

Introduction Secondary overtriage (OT) is the unnecessary transfer of injured patients between facilities. In low- and middle-income countries (LMICs), which shoulder the greatest burden of trauma globally, the impact of wasted resources on an overburdened system is high. This study determined the rate and associated characteristics of OT at a Malawian central hospital.

Methods A retrospective analysis of prospectively collected data from January 2012 through July 2017 was performed at Kamuzu Central Hospital (KCH) in Lilongwe, Malawi. Patients were considered OT if they were discharged alive within 48 h without undergoing a procedure, and were not severely injured or in shock on arrival. Factors evaluated for association with OT included patient demographics, injury characteristics, and transferring facility information.

Results Of 80,915 KCH trauma patients, 15,422 (19.1%) transferred from another facility. Of these, 8703 (56.2%) were OT. OT patients were younger (median 15, IQR: 6–31 versus median 26, IQR: 11–38, $p < 0.001$). Patients with primary extremity injury (5308, 59.9%) were overtriaged more than those with head injury (1991, 51.8%) or torso trauma (1349, 50.8%), $p < 0.001$. The OT rate was lower at night (18.9% v 28.7%, $p < 0.001$) and similar on weekends (20.4% v 21.8%, $p = 0.03$). OT was highest for penetrating wounds, bites, and falls; burns were the lowest. In multivariable modeling, risk of OT was greatest for burns and soft tissue injuries.

Conclusions The majority of trauma patients who transfer to KCH are overtriaged. Implementation of transfer criteria, trauma protocols, and interhospital communication can mitigate the strain of OT in resource-limited settings.

Introduction

Annually, injuries cause approximately six million deaths worldwide. There is a disproportionate burden of injury-related morbidity and mortality in low- and middle-income countries (LMICs), where healthcare resources to address them are least available [1, 2]. In the absence of an organized trauma system, access to trauma care is impeded by the same factors that hinder all surgical care, namely inadequate human resources, overcrowding, and the resultant delays to care [3, 4]. These treatment delays may increase morbidity and mortality, especially for severely injured patients [5].

Rebecca G. Maine
rebecca.maine@gmail.com

1 Department of Surgery, University of North Carolina at Chapel Hill, 4008 Burnett Womack Building, CB 7228, Chapel Hill, NC 27599, USA

2 Department of Surgery, Kamuzu Central Hospital, Box 149, Lilongwe, Malawi

3 Department of Surgery, Thomas Jefferson University, Philadelphia, PA, USA

4 Department of Surgery, University of Washington Harborview Medical Center, 325 Ninth Ave, Box 359796, Seattle, WA, USA

Many high-income countries (HIC) have integrated trauma systems that facilitate the rapid treatment and transfer of injured patients. Prehospital care and timely transport to facilities capable of stabilizing and providing appropriate specialty care are the cornerstones of these systems, reducing mortality by up to 20% [6]. Developed trauma systems are rare in LMICs, as are formalized prehospital and interfacility transport and communication. Furthermore, few hospitals are adequately equipped to treat severely injured patients.

Many LMICs, including Malawi, rely on tiered healthcare systems, where several district or rural hospitals provide basic care, including trauma care, while central or tertiary hospitals provide more complex services. District hospitals' limited resources result in frequent referrals to central hospitals for treatment, but little research has studied the clinical appropriateness of these transfers. Secondary overtriage (OT) is the inappropriate transfer of patients from one hospital to another facility capable of providing a higher level of care when this specialized care is not needed [7–9]. OT to central hospitals can increase workload and diminish workflow within an already overburdened system. This wastes important resources and further limits central hospitals' ability to deliver care for injured patients [6, 10].

The primary objective was to determine the rate of OT of injured patients at Kamuzu Central Hospital (KCH) in Lilongwe, Malawi's capital. The study also identified factors associated with OT, including patient, injury, and transferring health facility characteristics. We hypothesized that the majority of patients transferred to the central hospital in Lilongwe are overtriaged.

Materials and methods

We retrospectively analyzed the KCH trauma surveillance registry from January 2012 through July 2017. All patients who transferred to KCH from another health facility following their injury were included in this study. Patients presenting directly to KCH from the scene or missing outcomes data were excluded. Patients were considered OT if they were discharged alive within 48 h, from the emergency department (ED) or ward, without undergoing a procedure, unless they had a shock index > 0.9, initial GCS < 12, or a Malawi Trauma Score (MTS) > 18—associated with approximately a 10% risk of mortality [6, 10–13]. The MTS is a locally derived injury severity score incorporating age, sex, body region injured, AVPU (awake, verbal, pain, and unresponsive) score, and the presence of a radial pulse. Higher MTSs are associated with an increased mortality risk [12].

KCH is a 900-bed referral hospital in the capital of Malawi, Lilongwe. It is the tertiary hospital for eight district hospitals serving 6 million people in Malawi's central region. The ED has four beds and two additional rooms available for mass casualties. The ED is staffed by two rotating interns, three nurses, two clinical officers, and one on-call surgical resident and consultant. There is also a six-bed intensive care unit and a four-bed high dependency unit for both medical and surgical patients. Patients were referred from either a district hospital, a private hospital, or a public or private health center. District hospitals are typically rural hospitals staffed by clinical officers and one or fewer physicians where basic surgical care, primarily obstetric, is delivered. Health centers have limited inpatient facilities, are staffed by nurses, and provide very basic medical care. District hospitals can facilitate ambulance transport for urgent transfers, but patients at other facilities typically transfer via public or private transport, or private ambulance.

Descriptive statistics of patient and injury characteristics were calculated and reported as percentages and medians (interquartile ranges [IQR]). Bivariate association with OT and patient and injury characteristics were calculated using χ^2 and Wilcoxon rank-sum tests, as no continuous data were normally distributed. Modified Poisson's regression models, using robust standard errors, were built using the multiple modeling approach to evaluate the relative risk of OT for patient, clinical, and facility characteristics [14–17]. A priori factors likely associated with OT, such as age (pediatric < 18 years, elderly > 60 years), sex, mechanism of injury, body region injured, weekend presentation, nighttime admission, and type of injury, were included [16]. Because type of referring facility and time from injury to presentation at KCH were missing for many patients, but potentially associated with OT, the subgroup of patients with complete data was modeled separately. Patients were considered to have polytrauma if >1 body region was injured, unless all injuries were burns or fractures. Only bivariate associations with OT were calculated for the following variables due to either high numbers of missing values or collinearity with the other variables: distance to KCH from referring facility (in kilometers, calculated using Google Maps), the Kampala Trauma Score (KTS), the Revised Trauma Score (RTS) [18], and shock index [11]. p values < 0.05 were considered significant.

Results

From January 2012 through July 2017, 80,915 trauma patients were evaluated in the emergency department at Kamuzu Central Hospital; 13,119 (16.2%) were admitted.

A total of 15,421 (19.1%) patients transferred from other facilities. Of these, 245 (1.6%) died within 48 h of arrival, 57 (0.4%) arrived dead at KCH, 98 died in the ED (0.6%), and 90 (0.6%) died within 48 h of admission. Of all transferred patients, 8703 (56.2%) were OT. OT patients were primarily discharged from the ED, 7811 (89.8%), rather than the ward, 892 (10.3%).

Comparing appropriately transferred (AT) and OT patients, OT patients were younger, with a median of 15 years (6–31 years) compared to 26 years (11–38 years), $p < 0.001$. Women comprised an equal percent of each group, AT: 28.1% and OT: 29.4%, $p = 0.09$ (Table 1). For the 5223 (33.9%) patients with a documented time from injury to presentation at KCH, the median number of hours to arrival was similar between OT, 17 (5–41), and AT patients, 18 (5–48). The weekend admission rates were also similar, AT (1469, 21.8%) and OT (1772, 20.4%), $p = 0.03$, while nighttime admission rates were higher for AT patients (28.7%, $n = 1928$) than OT patients (18.9%, $n = 1646$), $p < 0.001$.

Injury characteristics and mechanisms also varied between OT and AT patients. OT patients had lower MTS, 8 (6–10) versus 9 (6–12) for AT patients, $p < 0.001$. Excluding the 126 patients (1.7%) with an MTS > 18, who were classified as AT, did not change this difference. The MTS, however, was only available for 41.4% ($n = 6385$) of patients. Injuries to the extremities had an OT rate of 59.9% ($n = 5308$), compared to 51.8% ($n = 1991$) of head injuries and 50.8% ($n = 1349$) of torso injuries, $p < 0.001$. The lowest OT rates were burns (30.9%, $n = 322/1041$) and motor vehicle collisions (47.3%, $n = 2107/4454$); penetrating wounds (75.4%, $n = 911/1208$, $p < 0.001$) and bites from animals and humans (69.6%, $n = 213/306$) were highest. OT occurred in over half of falls, (64.9%, $n = 3337/5144$) and assaults (54.7%, $n = 1234/2257$) (Table 1). OT rates were lowest in head injuries ($n = 378/1504$, 25.1%), burns ($n = 309/1029$, 30%), and internal organ injuries ($n = 154/588$, 26.2%) and highest for soft tissue injuries ($n = 4435/6466$, 68.6%) and dislocations ($n = 598/877$, $n = 68.2\%$). Polytrauma was present in 23.8% of patients ($n = 3674$), who most commonly had head trauma (24.3%, $n = 891$), fractures (25.4%, $n = 935$), and soft tissue injuries (63.9%, $n = 2350$). For patient with polytrauma, only 40% ($n = 1463/3674$) were OT.

The referring facility was documented for 33.8% ($n = 5214$) of transferred patients. Most patients transferred from either a health center, 2463 (47.2%), or district hospital, 1996 (38.3%) (Table 2). Central hospital transfers were rare (28, 0.5%). The OT percent was highest from private clinics (163/232, 70.3%, $p < 0.001$), followed by health centers (1476/2463, 59.6%, $p < 0.001$), then district hospitals (945/1996, 46.8%, $p < 0.001$), and lastly private hospitals (206/498, 41.4%, $p < 0.001$). Table 3 shows the distribution of OT and AT for the 1975 patients transferred from the eight district hospitals in KCH's catchment area (Fig. 1). OT rates were significantly higher for patients transferring from Bwaila, the district hospital in Lilongwe (64.4%, $p < 0.001$).

Distance from referring facility to KCH could be calculated for 46.3% (2415/5214) of transfers. OT patients travelled significantly shorter distances than AT patients, median 4.1 km (4.1–52.7 km) versus 52.7 km (4.1–111 km), $p < 0.001$. Bwaila Hospital, the closest district hospital, had both the largest number of patients, ($n = 1054$, 52.5%), and nearly twice the OT rate of any other district hospitals. A separate analysis of the distance for OT and AT patients excluding Bwaila patients showed a statistically but not clinically significant difference in the median distance, OT patients 89.6 km (29.3–111) and AT patients 91.5 km (52.7–127), $p < 0.001$.

The final Poisson's model included all candidate variables [14] (Table 4). Pediatric patients had a higher risk of OT than adults aged 18–60, RR 1.29, 95% CI: 1.25–1.33, $p < 0.001$. Compared to patients who fell, patients injured in MVCs had a 10% lower risk of OT, $p = 0.001$. Compared to head injuries, all other types of injuries had a higher risk of OT, with burn and soft tissue injuries having the highest risk, RR 2.81 (95% CI: 2.29, 3.44, $p < 0.001$) and 2.16 (95% CI: 1.93, 2.42, $p < 0.001$), respectively. On adjusted analysis, dislocations and soft tissue injuries were associated with a 85% and 116% increased risk of OT, respectively, $p < 0.001$. Patients who transferred at night had a 14% lower relative risk of OT, $p < 0.001$. In patients with complete transferring facility and time from injury data ($n = 5185$, 33.6%), the risk of OT was the same for private hospitals and district hospitals, while health centers and private clinics had a RR of 1. 25 (95% CI: 1.12, 1.38) and 1.4 (95% CI: 1.22, 1.59), respectively, $p < 0.001$ (Table 5).

While the overall crude burn OT rate was low, the adjusted relative risk of OT for burn patients was high. Thus, total body surface area burned (TBSA) was compared for OT and AT patients. TBSA was available for 539 burned patients (52.3%). Median TBSA was significantly higher in AT patients, 18% (10–30%), than OT patients, 4% (2–10%), $p < 0.001$. The vast majority of OT burn patients were discharged from the ED, 89.6% ($n = 277$), and most burn OT was children, 87.3% ($n = 269$).

Discussion

This study shows a high rate of secondary overtriage for injured patients at KCH, with 56.2% of transferred trauma patients discharged within 48 h of presentation without undergoing a procedure. The vast majority of OT patients,

Table 1 Patient and injury characteristics for appropriately transferred and secondarily overtriaged patients between 2012 and 2017 at Kamuzu Central Hospital

	Total	Appropriate transfers	Secondary overtriage	*p* value
Number of patients *n* (%)	15,4221	6726 (43.6)	8695 (56.4)	
Age in years, median (IQR)[a]	21 (8–34)	26 (11–38)	15 (6–31)	<0.001
Female sex *n* (%)	4442 (28.8)	1890 (28.1)	2552 (29.4)	0.09
Time from injury to arrival at KCH in hours, median (IQR)[b]	17 (5–44)	18 (5–48)	17 (5–41)	0.001
Nighttime admission, *n* (%)	3574 (23.2)	1928 (28.7)	1648 (18.9)	<0.001
Weekend admission, *n* (%)	3241 (21)	1469 (21.8)	1772 (20.4)	0.03
Malawi Trauma Score, med (IQR)[c]	8 (6–11)	9 (6–12)	8 (6–10)	<0.001
Mode of arrival at KCH, *n* (%)				<0.001
Minibus	4759 (31)	1274 (26.8)	3485 (73.2)	
Private vehicle	1522 (9.9)	617 (40.5)	905 (59.5)	
Ambulance	8145 (53.1)	4545 (55.8)	3600 (44.2)	
Other	914 (5.9)	265 (29)	649 (71)	
Shock, *n* (%)[d]	713 (12.4)	717 (25)	n/a	n/a
Body region with worst injury, *n* (%)[e]				<0.001
Head	3847 (25)	1856 (48.3)	1991 (51.8)	
Torso	2656 (17.3)	1307 (49.2)	1349 (50.8)	
Extremity	8858 (57.7)	3550 (40.1)	5308 (59.9)	
Mechanism of injury, *n* (%)[f]				<0.001
Motor vehicle[g]	4454 (29.1)	2347 (52.7)	2107 (47.3)	<0.001
Falls	5144 (33.6)	1807 (35.1)	3337 (64.9)	<0.001
Penetrating wound	1208 (7.9)	297 (24.6)	911 (75.4)	<0.001
Burn[h]	1031(6.7)	709 (69.1)	322 (30.9)	<0.001
Assault	2257 (14.8)	1023 (45.3)	1234 (54.7)	0.087
Bite (human or animal)	306 (2)	93 (30.4)	213 (69.6)	<0.001
Other blunt trauma	897 (5.9)	405 (45.1)	492 (54.9)	0.359
Type of injury[i]				
Head injury	1504 (9.7)	1126 (74.9)	378 (25.1)	<0.001
Fracture	5509 (35.7)	3239 (58.8)	2270 (47.7)	<0.001
Burn	1029 (6.7)	720 (70)	309 (30)	<0.001
Internal organ injury	588 (3.8)	434 (73.8)	154 (26.2)	<0.001
Dislocation	877 (5.7)	279 (31.8)	598 (68.2)	<0.001
Penetrating injury	547 (3.5)	319 (58.3)	228 (41.9)	<0.001
Soft tissue injury	6466 (42)	2031 (31.4)	4435 (68.6)	<0.001
Other	1777 (7.7)	238 (20.2)	9 39 (79.8)	<0.001
Polytrauma[j]	3674 (23.8)	2193 (60)	1463 (40)	<0.001
Head injury	884 (24.2)	714 (80.8)	170 (19.2)	
Fracture	930 (25.4)	742 (79.8)	188 (20.2)	
Burn	689 (18.9)	543 (78.8)	146 (21.2)	
Internal organ injury	297 (8.1)	236 (79.5)	61(20.5)	
Dislocation	85 (2.3)	41 (48.2)	44 (51.8)	
Penetrating injury	147 (4)	91 (61.9)	56 (38.1)	

Table 1 continued

	Total	Appropriate transfers	Secondary overtriage	*p* value
Soft tissue injury	2344 (64.1)	1123 (47.9)	1221 (52.1)	

[a]IQR—interquartile range

[b]Available for 5223 (33.9%)

[c]Available for 6385 (41.4%) patients; 126 patients with MTS > 18, where risk of mortality starts to increase, were considered appropriately transferred. In total, 19 were discharged within 48 h (23.2%)

[d]Shock index (heart rate/systolic blood pressure) > 0.9; available for 5769 (37.4%)

[e]Missing for 61 (0.4%) patients

[f]Missing for 125 (0.8%) patients

[g]Includes pedestrians injured by vehicles

[h]Includes electrocution and inhalation injuries

[i]Some patients had multiple injuries

[j]Of the polytrauma patients, the frequency of each type of injury is listed

Table 2 Secondary overtriage by type of referral facility and distance from KCH

	Total *N* (%)	Appropriate transfer	Secondary overtriage	*p* value
Type of transferring facility, *n* (%)[a]	5214 (33.8)			<0.001[b]
Central hospital	28 (0.5)	15 (52.6)	13 (46.4)	0.437
District hospital	1996 (38.3)	1051 (52.7)	945 (47.3)	< 0.001
Private hospital	495 (9.5)	290 (58.6)	205 (41.4)	<0.001
Health center	2463 (47.2)	987 (40.1)	1476 (59.9)	<0.001
Private clinic	232 (4.5)	69 (29.7)	163 (70.3)	<0.001
Missing	10,208 (66.2)	4315 (64.1)	5893 (67.8)	–
Distance to KCH in km, median (IQR)[c]	16.8 (4.1 – 98.6)	52.7 (4.1 – 111)	4.1 (4.1 – 52.7)	<0.001

[a]Transferring facility was recorded for 34% of patients

[b]*p* value remains the same when missing values excluded

[c]Available for 2451 (46.5.1%) of all patients with documented transferring facilities treated at either central hospitals, district hospitals, or private facilities

89%, did not require admission to the hospital. OT was common from all types of facility at > 40%, but highest from clinics and health centers, and facilities closest to KCH.

OT can overwhelm receiving facilities' capacity to deliver care, resulting in inappropriate use of specialized resources [6]. Studies of OT in well-developed trauma systems found 10–40% of patients were overtriaged to level I trauma centers [6–9], with almost half of pediatric patients being overtriaged in some rural trauma systems [9]. OT in many LMICs is more nuanced than in the HIC where standard procedures, imaging, and laboratory technologies are widely available. Like many sub-Saharan countries, Malawi's referring facilities have limited radiology and laboratory capacity [19, 20]. When plain radiography is only intermittently available at some district hospitals, patients may appropriately transfer to obtain X-rays, likely contributing to the high prevalence of extremity injuries in this OT cohort [21]. Specialist consultation with general surgeons, orthopedic surgeons, and neurosurgeons are not available at district hospitals or health centers where clinical officers (non-physicians) provide the majority of care [22–24]. While OT rates due to infrastructure and personnel could be decreased by improved access to biomedical engineering [21], developing telemedicine programs [20, 25], and real-time information about resource availability at different hospitals to optimize transfers for imaging, an ideal transfer metric in this context would incorporate transfer indications and the resources available at the referring and receiving facilities.

Table 3 Appropriateness of transfer by Central Region District hospitals

	Distance in km[a]	Total *n* (%)	Appropriate transfer *n* (%)	Secondary overtriaged *n* (%)
Total patients		1975	1043 (52.8)	932 (47.2)
Dedza	89.6	223 (11.3)	147 (65.9)	76 (34.1)
Dowa	52.7	102 (5.2)	66 (64.7)	36 (35.3)
Kasungu	127	102 (5.2)	69 (67.7)	33 (32.4)
Bwaila	4.1	1044 (52.9)	372 (35.6)	672 (64.4)
Mchinji	111	141 (7.1)	91 (64.5)	50 (35.5)
Nkhotakota	199	83 (4.2)	72 (86.8)	11 (13.5)
Ntcheu	159	150 (7.6)	116 (77.3)	34 (22.7)
Ntchisi	91.5	45 (2.3)	40 (88.9)	5 (11.1)
Salima	98.6	85 (4.3)	70 (82.4)	15 (17.7)

[a]Shortest driving distance to Kamuzu Central Hospital as measured by Google Maps

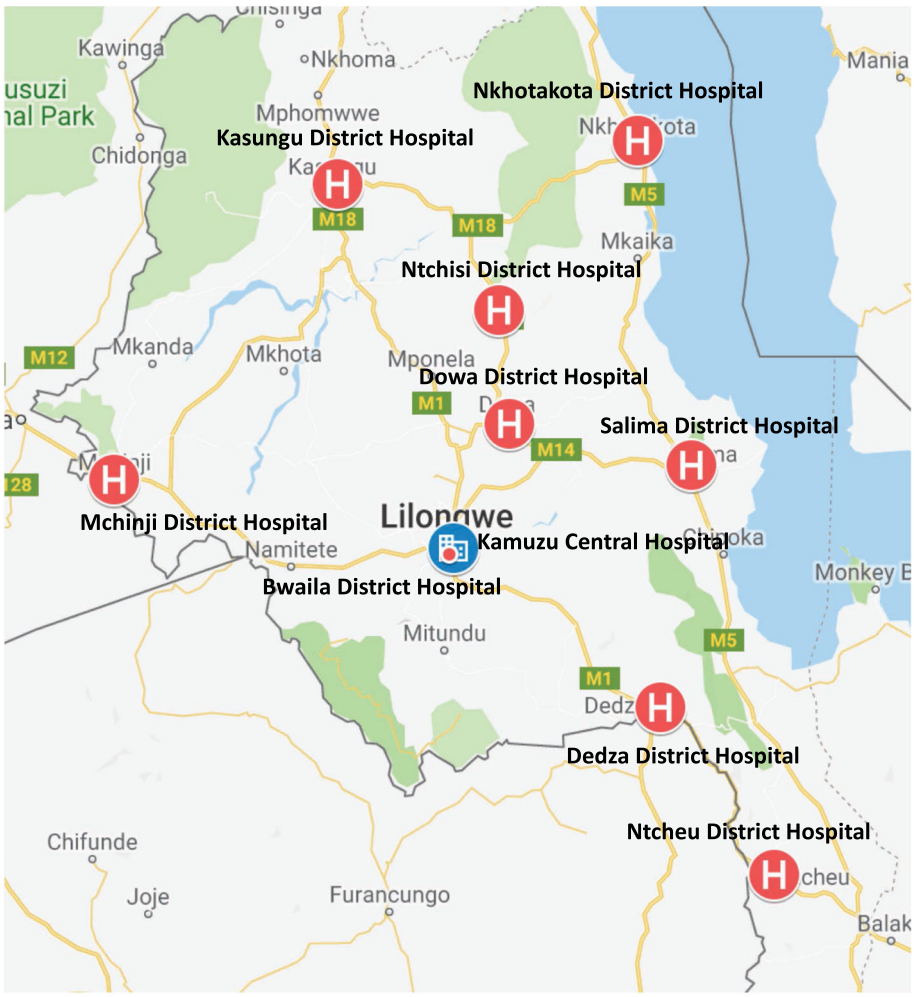

Fig. 1 Map of one central and eight district hospitals in the central region of Malawi

Monitoring crude OT, even if imperfect, can be used as a proxy for trauma system development and quality improvement in LMICs.

Transfer protocols and guidelines are essential to trauma systems to help providers recognize the need for transfer and facilitate expediency [26]. Currently, Malawi has no formal transfer protocols, leading to inconsistent transfer

Table 4 Multiple Poisson's regression of patient, injury, and facility factors associated with secondary overtriage for injuries to Kamuzu Central Hospital

	Relative risk	95% CI	*p* value
Age			
0 to 17 years	1.29	1.25, 1.33	<0.001
18 to 60 years	Ref	–	–
>60 years	0.73	0.66, 0.80	<0.001
Female sex	0.97	0.94, 1	0.06
Injury mechanism			
Fall	Ref		
Motor vehicle collision	0.9	0.87, 0.94	<0.001
Bite (human or animal)	0.84	0.65, 1.09	0.18
Penetrating injury	0.97	0.91, 1.02	0.24
Burn/electrocution	0.41	0.36, 0.47	<0.001
Assault	1.02	0.98, 1.07	0.23
Other blunt	0.88	0.83, 0.94	<0.001
Injury category[a]			
Head injury	Ref		
Polytrauma	1.34	1.19, 1.51	<0.001
Fracture	1.16	1.03, 1.31	<0.001
Burn	2.81	2.29, 3.44	<0.001
Internal organ injury	0.97	0.78, 1.18	0.7
Dislocation	1.85	1.64, 2.1	<0.001
Penetrating injury	1.26	1.08, 1.47	0.006
Soft tissue injury	2.16	1.93, 2.42	<0.001
Other	2.07	1.83, 2.36	<0.001
Most injured body region			
Head	0.93	0.89, 0.96	<0.001
Torso	0.90	0.86, 0.94	<0.001
Extremity	Ref		
Nighttime presentation to KCH	0.86	0.83, 0.89	<0.001
Weekend admission to KCH	1.03	1, 1.07	0.05

[a]Polytrauma was injury to more than one body part, unless all injuries were orthopedic/soft tissue, or burns. Fractures to face and chest were not considered isolated orthopedic injuries

patterns reliant on provider discretion. This is highlighted by the significant differences observed in OT rates by facility type and between district hospitals. Significantly more AT patients arrived to KCH by ambulance than either minibus or private car, suggesting that referring providers do some pretransfer triage to determine which patients warrant formal transport. Developing transfer protocols, including context-appropriate triage scores, could decrease OT rates and requires limited financial investments.

Improved communication, between referring and receiving providers, is another low-cost intervention to decrease OT [26]. Providers in Malawi have developed an informal solution to communication challenges: a WhatsApp group where referring providers solicit advice from central hospital specialists. However, this is not routine, and even critically ill patients frequently arrive without prior notification, limiting the trauma team's ability to prepare. Low-cost solutions to reduce OT include a dedicated trauma phone that referring providers could call to discuss potential referrals, and improved telemedicine and telementoring capacities [27–30].

This study identified that children, people with small TBSA burns, and those with dislocations were at high risk of OT. High transfers of minor pediatric injuries likely reflect minimal comfort on the part of rural providers to care for children who may need procedures [9, 23]. District hospital clinical officers have basic surgical skills and regularly perform caesarian sections and basic splinting/casting. Clinical officers with orthopedic specialty training also staff district hospitals and are trained to manage dislocations. Additional clinical officer education focused on pediatric injuries, dislocations, open reduction and fixation of fractures, and management of small TBSA burn is within their scope of practice and could reduce OT.

This study retrospectively analyzed a prospective trauma registry and is subject to the limitations of this study design. The specific reason for referral and early discharge could not be discerned. Furthermore, undertriage leading to preventable deaths from injury at referring facilities could not be determined. Future studies will address this using the recently established trauma registry at one district hospital in KCH's catchment, which includes information about reasons for transfer and delays in transfer. The appropriateness of immediate discharge was also not assessed. For example, some dislocations may have been reduced without procedure documentation, making the discharge appropriate. However, even when all patients with dislocations were considered AT, the OT rate remains 52.3%. This analysis could not identify how many of the patients presented to the ED to schedule outpatient appointments with specialists. While this likely drove many of the referrals from the local district hospital, this still represents a significant misuse of limited emergency and patient resources.

In conclusion, the rate of secondary overtriage to the only referral hospital in the central region of Malawi is high and results, in part, from the lack of a formal trauma system. Improved communication and trauma protocols

Table 5 Multiple Poisson's regression of patient, injury, and facility factors associated with secondary overtriage for injuries to Kamuzu Central Hospital for the subgroup of patients with available referring facility information

	Relative risk	95% CI	*p* value
Age			
0 to 17 years	1.16	1.1, 1.23	<0.001
18 to 60 years	Ref	–	–
>60 years	0.67	0.55, 0.8	<0.001
Female sex	0.96	0.92, 1.02	0.18
Injury mechanism			
Fall	Ref		
Motor vehicle collision	0.9	0.83, 0.96	0.003
Bite (human or animal)	0.81	0.55, 1.2	0.29
Penetrating injury	0.97	0.87, 1.09	0.63
Burn/electrocution	0.48	0.38, 0.61	<0.001
Assault	1.02	0.94, 1.08	0.67
Other blunt	0.9	0.81, 1	0.05
Type of injury[a]			
Head injury	Ref		
Polytrauma	1.11	0.92, 1.34	0.26
Fracture	0.8	0.65, 0.96	0.02
Burn	2.14	1.5, 3	<0.001
Internal organ injury	0.68	0.45, 1.02	0.07
Dislocation	1.4	1.15,1.72	0.001
Penetrating injury	0.75	0.51,1.1	0.15
Soft tissue injury	1.65	1.38, 1.98	<0.001
Other	1.67	1.35, 2.08	<0.001
Most injured body region			
Head	0.9	0.84, 0.97	0.004
Torso	0.87	0.8, 0.94	<0.001
Extremity	Ref		
Nighttime presentation to KCH	0.85	0.79, 0.91	<0.001
Weekend admission to KCH	1.01	0.95, 1.07	0.73
Transferring facility			
District hospital	1.06	0.95, 1.19	0.28
Private hospital	Ref		
Health center	1,25	1.12, 1.39	<0.001
Private clinic	1.39	1.22, 1.6	<0.001
Hours from injury to presentation at KCH	1	1, 1	0.11

[a]Polytrauma was injury to more than one body parts, unless all injuries were orthopedic/soft tissue, or burns. Fractures to face and chest were not considered isolated orthopedic injuries

could decrease the additional burden placed on both the healthcare system and individual patients from these transfers. A large portion of OT was extremity injuries, small burns, and soft tissue injuries; the capacity to treat these injuries at district hospitals must be improved to decrease OT rates. Monitoring and analysis of OT rates may provide useful information to support trauma system development in LMICs.

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Compliance with ethical standards

Conflict of interest None of the authors have any conflict to declare.

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