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Feasibility and acceptability of mobile phone-based triage tool to identify discharged trauma patients in need of further care in Cameroon

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ABSTRACT

Background Lack of routine follow-up for trauma patients after hospital discharge likely contributes to high rates of injury-related complications in Cameroon. Mobile phone contact may facilitate timely follow-up and reduce disability for high-risk patients. A previous single-center study showed promising feasibility of mobile health (mHealth) triage, but generalizability remains unknown. We evaluated the feasibility and acceptability of implementing a postdischarge mHealth triage tool at four hospitals in Cameroon.

Methods Trauma patients from four Cameroonian hospitals were contacted at 2 weeks, 1, 3, and 6 months postdischarge. Program feasibility was assessed by calculating the proportion of successful contacts and overall cost. Odds of successful contact were compared using generalized estimating equations across patient socioeconomic status. Acceptability was assessed using a structured patient survey at 2 weeks and 6 months postdischarge.

Results Of 3896 trauma patients, 59% were successfully contacted at 2 weeks postdischarge. Of these, 87% (1370/1587), 86% (1139/1330), and 90% (967/1069) were successfully reached at the 1-month, 3-month, and 6-month timepoints, respectively. The median cost per patient contact was US$3.17 (IQR 2.29–4.29). Higher socioeconomic status was independently associated with successful contact; rural poor patients were the least likely to be reached (adjusted OR 0.11; 95% CI 0.04 to 0.35). Almost all surveyed patients reported phone-based triage to be an acceptable follow-up method.

Conclusion Telephone contact is a feasible and acceptable means to triage postdischarge trauma patients in Cameroon. While scaling an mHealth follow-up program has considerable potential to decrease injury morbidity in this setting, further research is needed to optimize inclusion of socioeconomically marginalized groups.

Level of evidence Level III, prospective observational study.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Despite high injury mortality and morbidity rates in Cameroon, routine follow-up after hospital discharge is not currently feasible due to resource and provider constraints.
⇒ Early identification of patients who would benefit from further care may facilitate prompt treatment for high-risk patients and mitigate complications, injury-related disability, and death.

WHAT THIS STUDY ADDS

⇒ Telephone-based triage is an acceptable and feasible follow-up method among postdischarge trauma patients in Cameroon.
⇒ Higher socioeconomic status was independently associated with successful contact with rural poor patients being the least likely to be reached.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ As participation is critical to optimize any programmatic intervention's impact, these results are promising for broader implementation of triage tool.
⇒ Inclusion of socioeconomically marginalized groups must be prioritized in future research.

BACKGROUND

WHO estimates that 90% of injury-related deaths occur in low-income and middle-income countries (LMICs).[1] Moreover, injury-related death rates in LMICs have been rising steadily with increasing industrialization.[2–4] In Cameroon, an LMIC in central Africa, injury mortality rates are greater than deaths attributable to malaria and tuberculosis combined.[5] Since 2015, a multisite Cameroon National Trauma Registry (CTR) has collected ongoing prospective data on injury to identify targets for trauma process improvements.[6 7] However, routine follow-up for trauma patients is not currently feasible in Cameroon due to resource and provider constraints. Consequently, most trauma patients return to hospital care only once complications develop.[6 8] Early identification of patients who would benefit from further care may facilitate prompt treatment for high-risk patients and mitigate complications, injury-related disability, and death.

Demographic and health survey and cross-sectional injury surveillance data demonstrate high penetrance of cellular telephone access among Cameroonians (95% in the Southwest Region of Cameroon).[9 10] Widespread utilization of mobile

telephones makes telephone contact a potentially high-impact target for increasing access to follow-up care in a resource-constrained trauma setting where universal follow-up is not feasible. If successful, telephone triage could help to direct the limited available resources toward the highest risk patients, preventing unnecessary morbidity due to injury. However, implementation of mobile health (mHealth) follow-up programs critically depend on patient participation. A single-center pilot of an mHealth follow-up triage tool demonstrated promising feasibility of an mHealth follow-up triage program, but the generalizability of these results has not yet been established.[11] In particular, as cellphone ownership is known to be a marker of socioeconomic status among Cameroonians, program feasibility may vary by socioeconomic group.[12] In order to support broader implementation and scaling efforts, rigorous evaluation of the feasibility and acceptability of mHealth follow-up contact is needed. The objective of this study was to determine the feasibility and acceptability of cellular phone-based triage as part of a multisite validation trial. To develop strategies to optimize future implementation, we characterized associations between socioeconomic status, injury characteristics, and feasibility of cellular telephone contact.

METHODS

Design, setting, and population

We evaluated implementation of a mobile telephone follow-up program in a cohort of Cameroonian trauma patients hospitalized for injury at four study sites between June 2019 and December 2021. The previously described CTR collects ongoing prospective data on all injured patients admitted for injury at Limbe Regional Hospital, Laquintinie Hospital of Douala, Edea Regional Hospital, and Catholic Hospital Pouma. All patients enrolled in the CTR who were discharged after hospital admission for injury were eligible for inclusion in the mobile follow-up program.

All participants were contacted postdischarge via mobile phone by research assistants at four timepoints: 2 weeks, 1 month, 3 months, and 6 months. CTR patients who were unable to provide a cellular phone number or those with missing date of death or availability at 2 weeks were excluded.

At each timepoint, participants were contacted at least three times by calling and once by text message over a 1-week interval. At the 2-week and 6-month timepoints, a subset of participants was also asked to complete an acceptability survey. This 5 minute survey included six yes/no questions assessing perceived convenience, acceptability, and utility of mobile telephone follow-up.

Data were documented on paper forms and entered into Research Electronic Data Capture by research assistants hosted on University of California Los Angeles server.[13]

Variables

The primary outcome of feasibility was the proportion of enrolled patients successfully contacted at each timepoint, defined as answering the phone and being available on at least one of three attempts. Secondary feasibility outcomes of interest included number of call attempts, cost per contact, and patient-reported acceptability.

CTR data were extracted for enrolled patients and tested for associations with telephone contact feasibility. Variables extracted included sex, age, injury characteristics, household demographics, occupation, education level, alcohol use, and discharge status. Patients were categorized into socioeconomic clusters using the previously validated Cameroon *EconomicCluster* model. Specifically, patient household demographic information across five dimensions (urban or rural location, home ownership status, cellphone ownership, agricultural land ownership, and type of cooking fuel used) was used to identify each patient as belonging to rural poor, rural wealthy, urban middle-class homeowners, urban middle-class tenants, or urban wealthy household socio-economic status (SES) clusters.[12 14]

Resource utilization was defined as personnel time and cost per patient contact. Research assistants documented time to administer survey per patient. Program costs for the study period were retrieved from each hospital, which accounted for personnel, patient travel and call time reimbursement, and research infrastructure. Cost per patient contact were calculated by dividing the total cost by the number of patients per hospital over the study duration. Acceptability survey responses were summarized as proportions of enrolled patients. The Strengthening the Reporting of Observational Studies in Epidemiology guidelines was used to ensure proper reporting of methods, results, and discussion (online supplemental file 1).

Statistical analysis

Categorical variables are reported as frequencies and percentages of enrolled patients. Continuous variables are reported as means with SD for normally distributed variable or medians with IQR for non-parametric variables. Differences between groups were tested with χ^2 test for categorical variables and Wald test for continuous variables.

Since each participant was contacted at multiple timepoints, we assessed risk-adjusted feasibility using a repeated-measures analysis. We used a generalized estimating equation (GEE) model with binary distribution and logit link function to calculate ORs with 95% CIs for correlated observations.[15 16] For all analyses, we set α at 0.05. Data were analyzed using Stata (V.16.1, StataCorp, College Station, Texas, USA).[17]

RESULTS

Of 4511 CTR patients admitted during the study period and consented for cellular telephone contact, 3896 were eligible for postdischarge follow-up (figure 1). The remaining 615 patients were excluded for in-hospital mortality (n=247, 5.5%), missing date of death (n=82, 1.8%), or missing availability at the first timepoint (n=286, 6.3%). The telephone follow-up cohort was representative of a standard young, male predominant trauma population. Patient demographics, injury characteristics, and clinical course of the telephone follow-up cohort are reported in table 1. Of note, only 9.4% of participants lived in a rural setting and 19.8% of patients reported being unable to receive recommended medical care due to prohibitive healthcare costs (table 1). Among the cohort, 81.0% had access to cellphones while 1.9% did not and the remaining 17.1% had an unknown status.

Feasibility

Overall, 2304 (59%) of 3896 enrolled patients were successfully contacted at 2 weeks postdischarge. Of those successfully contacted at subsequent 1-month, 3-month, and 6-month timepoints, 87% (1370/1587), 86% (1139/1330), and 90% (967/1069) of patients were successfully reached, respectively. Among the 1592 patients who were not reached at the 2-week timepoint, only 26 (1.6%) were successfully contacted at subsequent timepoints.

At each timepoint, it took a median of 1 call attempt (IQR 1–1) to successfully contact participants. Patients who were

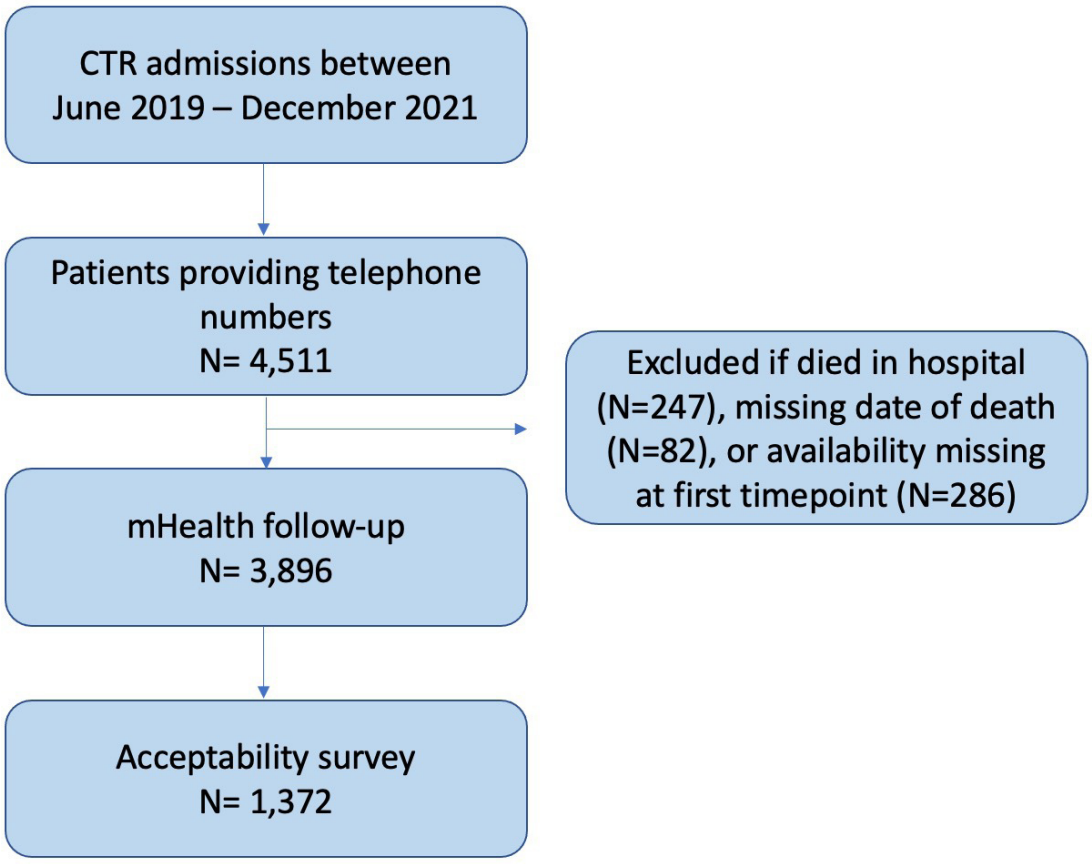

Figure 1 Consolidated Standards of Reporting Trials diagram for mobile health (mHealth) follow-up cohort. CTR, Cameroon National Trauma Registry.

successfully contacted at the 2-week timepoint were more frequently female (58.8% vs 41.2%; p=0.007), had completed more years of education, and were less commonly members of the rural poor SES group (table 2; all p<0.05). Rates of successful contact did not differ by age or injury location (table 2).

Call times were recorded for 1070 patients who completed the triage survey. Median call time was 57 seconds (IQR 43–92). The median cost per patient contact was US$3.17 (IQR 2.29–4.29). Cost varied by hospital site: median cost per contact was highest at Edea Regional Hospital at US$4.43 (IQR US$3.32–US$5.71) compared with 3.94 (US$2.38–US$5.62), 2.60 (US$1.88–US$3.76), and 1.72 (US$1.58–US$2.08) at Catholic Hospital Pouma, Limbe Regional Hospital, and Laquintinie Hospital of Douala, respectively (p<0.001).

Respondent distribution

At all timepoints the most common survey respondent was the patient themselves, followed by a surrogate. The proportion of patients responding increased overtime from 50.0% at the 2-week timepoint to 58.9% at the 6-month timepoint.

Adjusted association with feasibility

The GEE model revealed SES was independently associated with feasibility, with rural poor patients least likely to be successfully contacted (adjusted OR (AOR) 0.11; 95% CI 0.04 to 0.35) compared with urban wealthy patients. With male as reference, female sex was linked to increased odds of contact (AOR 1.46; 95% CI 1.00 to 2.12). Compared with discharge home, transfer to another hospital was associated with reduced odds of successful contact (AOR 0.55; 95% CI 0.31 to 0.98). Compared with Laquintinie Hospital of Douala, Catholic Hospital Pouma (AOR 2.10; 95% CI 1.09 to 4.04) and Edea Regional Hospital (AOR 5.19; 95% CI 2.53 to 10.66) were associated with increased odds of successfully contacting patients. Limbe Regional Hospital had the inverse relationship (AOR 0.38; 95% CI 0.26 to 0.55).

Acceptability

Among a subset of discharged patients, 1372 were contacted to complete the acceptability survey 2 weeks postdischarge while 570 were contacted after 6 months. Overall, respondents at both 2 weeks and 6 months found telephone contact to be highly acceptable. Approximately 98.6% of participants believed mobile phone to be a convenient way to be contacted with >90% of surveyed patients responding positively to all acceptability questions (table 3). The proportion of patients willing to go to a clinic or hospital if recommended during the phone call increased with time (91.4% at 2 weeks vs 97.5% at 6 months, p<0.01). Similarly, more patients at 6 months reported that they would be willing to send a picture to a healthcare provider to aid in evaluation (93.5% vs 95.6%; p<0.001).

DISCUSSION

In this prospective multisite implementation study, we present the first longitudinal evaluation of an mHealth trauma follow-up program in Cameroon. We found mobile phone contact to be both a feasible and highly acceptable mechanism to triage injured patients for follow-up care after hospital discharge, with nearly

Table 1 Demographics, injury characteristics, and hospital course for patients enrolled in telephone follow-up program

	N	%
Age, median (IQR)	32 (24–42)	
Female sex	804	24.9
Rural	365	9.4
Household SES cluster		
Rural poor	29	1.5
Rural wealthy	244	12.9
Urban poor	23	1.2
Urban middle-class homeowners	171	9.0
Urban middle-class tenants	865	45.6
Urban wealthy	564	29.8
Occupation		
Unemployed	122	6.2
Employed	1259	64.2
Student or child	274	14.0
Housewife/Husband	121	6.2
Retired	42	2.1
Other	142	7.2
Cellphone access		
Yes	3156	81.0
No	73	1.9
Unknown	667	17.1
Travel distance (km)		
<5	399	22.3
5–10	484	24.8
10–50	917	47.1
>50	149	7.6
Injury mechanism		
Blunt	1195	37.3
Penetrating	287	9.0
Mixed	1663	51.9
Neither/Other	58	1.8
Injury location		
Head and neck	46	10.2
Face	153	34.0
Chest	17	3.8
Abdomen	3	0.7
Pelvis	3	0.7
Spine	2	0.4
Extremity	226	50.2
Injury intent		
Unintentional	2812	87.0
Intentional (self-harm)	14	0.4
Intentional (assault/homicide)	358	11.1
Legal intervention/War operations	5	0.2
Events unclear	7	0.2
Unknown	35	1.1
Education		
No formal education	124	4.1
Primary school	720	23.5
Secondary/High school	1750	57.1
Tertiary/College	411	13.4
Other	12	0.4
Alcohol use		
No	2585	80.1
Yes	289	9.0
Unknown	355	11.0
Triage disposition		
Home	1264	64.2
Home to die	5	0.3
Left against medical advice	463	23.5
Transferred	237	12.0
Cost prevented medical care	636	19.8
Hospital		
Catholic Hospital Pouma	350	9.0
Laquintinie Hospital of Douala	1799	46.2
Edea Regional Hospital	462	11.9
Limbe Regional Hospital	1285	33.0
Total patients reached	3896	

Variables reported as n (%), unless otherwise specified.
SES, socio-economic status.

all surveyed patients reporting that telephone contact was both convenient and acceptable for follow-up. As participation is critical to optimize program impact, these results are promising for broader implementation of such a triage tool.

Importantly, the majority of successfully contacted patients were reached at the earliest call timepoint, suggesting that additional contacts may be of limited utility for triage, with nearly all surveyed patients reporting that telephone contact was both convenient and acceptable. These findings bolster feasibility findings from prior single-site data[11] and provide the critical knowledge base needed to support scaling and optimization efforts for broader adaptation.

One key objective of this study was to understand how call response varied by contact point to maximize program feasibility and minimize redundancy. We found feasibility at the 2-week timepoint was consistent with findings from a prior single-center pilot assessment of the telephone triage tool (62% at 2 weeks)[11] but notably higher than previously reported estimates for telephone contact of trauma populations at 6 weeks after discharge in other LMICs. Specifically, Ethiopian trauma patients contacted via telephone follow-up at 6 weeks postdischarge were reached only 47% of the time.[18] Similarly, a study by Rapp *et al* reported 51% of patients were compliant with a telephone follow-up 6 weeks after discharge from a urological procedure.[19] It is not possible to fully delineate the likely multifactorial causes underlying the higher contact feasibility found in Cameroon, which may include difference in telephone penetrance over time and in different locations. However, our findings suggest that earlier contact postdischarge may be more feasible than later contact which has the secondary benefit that earlier identification of off-trajectory patients is more likely to result in improved outcomes. Ding *et al* demonstrated that 90% of postdischarge trauma deaths occurred within the first 2 weeks of leaving the hospital,[20] suggesting that contacting patients early after injury is critical to try to mitigate preventable morbidity and mortality. Conversely, patients were unlikely to be successfully contacted at subsequent timepoints if they were not reached at the 2-week timepoint (<1%) indicating that there is relatively little utility in pursuing later contact and these timepoints can be removed to improve overall program cost effectiveness.

Importantly, we identified significant differences in triage feasibility based on patient demographics. In both high-income and LMIC settings, patients from rural environments have

Table 2 Frequency of successful contact at each timepoint (2 weeks, 1 month, 3 months and 6 months) by patient demographic and hospital variables

	Availability T1			Availability T2			Availability T3			Availability T4		
	N	%	P value	N	%	P value	N	%	P value	N	%	P value
Sex			**0.007**			0.9			0.2			0.2
Male	1296	53.3		806	86.0		676	87.8		597	92.4	
Female	473	58.8		310	87.1		253	83.8		214	89.5	
Urban status			0.9			0.4			0.8			0.1
Rural	201	55.1		134	88.7		109	86.5		102	95.3	
Urban	1565	54.7		981	86.0		819	85.9		708	91.1	
Household SES cluster			**<0.001**			0.08			0.2			0.2
Rural poor	9	31.0		5	71.4		3	100.0		3	100.0	
Rural wealthy	140	57.4		92	91.1		78	86.7		75	96.2	
Urban poor	15	65.2		12	92.3		7	77.8		9	100.0	
Urban middle-class homeowners	73	42.7		47	82.5		39	75.0		34	97.1	
Urban middle-class tenants	514	59.4		344	87.5		291	86.1		251	90.9	
Urban wealthy	279	49.5		197	81.1		158	80.2		151	95.6	
Travel distance (km)			0.1			0.5			1.0			0.1
<5	238	59.7		137	86.7		118	90.8		103	88.0	
5–10	256	52.9		162	91.0		145	90.1		112	88.2	
10–50	533	58.1		310	90.9		259	91.2		237	92.2	
>50	78	52.4		48	90.6		41	89.1		33	100.0	
Injury mechanism			**0.001**			**<0.001**			0.07			**0.02**
Blunt	604	50.5		371	81.9		301	82.0		252	89.4	
Penetrating	156	54.4		96	82.8		88	86.3		66	85.7	
Mixed	964	58.0		628	90.5		519	88.0		477	93.9	
Neither/Other	31	53.5		13	68.4		12	92.3		8	80.0	
Injury location			0.6			0.9			1.0			0.07
Head and neck	25	54.5		16	88.9		12	75.0		11	100.0	
Face	72	47.1		35	83.3		27	79.2		24	92.3	
Chest	10	58.8		7	100.0		5	71.4		5	100.0	
Abdomen	2	66.7		1	100.0		1	100.0		0	0.0	
Pelvis	3	100.0		2	100.0		2	100.0		2	100.0	
Spine	1	50.0		1	100.0		1	100.0		1	100.0	
Extremity	118	52.2		61	85.9		48	80.0		38	80.9	
Injury intent			**0.001**			0.9			0.6			0.9
Unintentional	1578	56.1		997	86.3		830	86.4		726	91.4	
Intentional (self-harm)	6	42.9		6	100.0		6	100.0		6	100.0	
Intentional (assault/homicide)	162	45.3		100	87.0		83	82.2		73	93.6	
Legal intervention/War operations	1	20.0		1	100.0		1	100.0		1	100.0	
Events unclear	2	28.6		1	100.0		1	100.0		1	100.0	
Unknown	20	57.1		12	85.7		9	75.0		5	83.3	
Education			**<0.001**			0.6			**0.02**			1.0
No formal education	71	57.3		49	87.5		33	73.3		35	92.1	
Primary school	341	47.4		233	85.4		200	85.8		167	91/3	
Secondary/High school	989	56.5		601	86.7		502	87.8		440	91.5	
Tertiary/College	249	60.6		162	88.5		135	83.9		118	92.2	
Other	10	83.3		5	71.4		7	100.0		7	100.0	
Alcohol use			0.09			0.2			**0.005**			1.0
No	1440	55.7		914	85.7		749	84.5		658	91.6	
Yes	148	51.2		94	91.3		82	92.3		70	92.1	
Unknown	180	50.7		109	89.3		99	92.5		84	91.3	
Hospital			**<0.001**			**<0.001**			**<0.001**			**<0.001**
Catholic Hospital Pouma	237	67.7		178	96.2		158	98.1		151	98.7	
Laquintinie Hospital of Douala	1005	55.9		606	89.5		514	88.01		439	92.6	
Edea Regional Hospital	320	69.3		208	84.6		181	87.9		167	96.5	
Limbe Regional Hospital	742	57.7		378	78.9		286	75.5		210	78.1	

The bolded values on Table are those p-values that were statistically significant (i.e. less than 0.05).
SES, socio-economic status.

been found to have worse trauma outcomes than their urban counterparts, making increasing access among rural populations a particular priority.[21] Unfortunately, using the current triage protocol we identified reduced feasibility among the rural poor population. As such, there is a critical need to understand limitations in a telephone follow-up tool in different contexts

Table 3 Patient acceptability survey results at T1 (2 weeks) and T2 (6 months) after discharge

	T1, n (%)	T2, n (%)	P value
Willing to be contacted for follow-up by mobile phone (T1 n=1335, T2 n=570)	1328 (99.5%)	570 (100%)	1
Willing to be contacted for follow-up by mobile phone without compensation (T1 n=1321, T2 n=569)	1317 (99.7%)	569 (100%)	1
Willing to go to a clinic or hospital if recommended during mobile phone call (T1 n=1329, T2 n=568)	1215 (91.4%)	554 (97.5%)	<0.01*
Willing to send a picture to healthcare provider to help with evaluation (T1 n=1334, T2 n=570)	1247 (93.5%)	545 (95.6%)	<0.01*
Believe mobile phone is a convenient way to be contacted (T1 n=1330, T2 n=569)	1311 (98.6%)	566 (99.5%)	0.13
Inconveniences of mobile phone method (T1 n=1333, T2 n=568)			
No inconvenience at all	1146 (85.9%)	505 (88.9%)	<0.01*
There are a few inconveniences	173 (12.9%)	60 (10.6%)	
Burdensome	14 (1.1%)	3 (0.5%)	

*P<0.05.

to optimize uptake among marginalized populations. Notably, contact feasibility differed by admission hospital, with smaller regional and private hospitals demonstrating higher odds of successfully contacting patients compared with a larger referral tertiary hospital. With 81% of our cohort reporting cellphone access, future studies to assess mitigation strategies such as lending phones to high-risk participants who do not have access to telephones may be required to ensure equitable follow-up care among trauma patients. Notably, only 10% of the enrolled cohort identified as being from a rural community which may reflect failure to present to the hospital in this population.

The present study has several limitations. First, acceptability surveys were collected using convenience sampling and participants who completed surveys may be more likely to report favorable acceptability compared with those not willing to participate. As described above, patients identifying as rural are under-represented among the contacted cohort compared with the general population of Cameroon. Additionally, this study only targeted patients who already had engaged formal care and does not address access among patients who are not treated in the formal care system and who may be particularly vulnerable. The cost estimates were also based off total site costs, which included research personnel and patient reimbursements for call time and travel and thus maybe an overestimate for telephone triage. Conversely, there may be future costs required for program implementation that are not captured in these data that may limit the accuracy of our findings. Finally, while we present data demonstrating multisite feasibility from Cameroon, given the diversity of LMIC trauma systems, generalizability of our findings to other LMIC clinical settings may be variable.

In conclusion, we found telephone contact to be a feasible and acceptable means to triage postdischarge trauma patients in Cameroon. Contact at 2 weeks after injury appears to be feasible and is early enough to facilitate prompt repatriation into care. While scaling a telephone follow-up program has considerable potential to decrease injury morbidity in this setting, further research is needed to optimize inclusion of socioeconomically marginalized groups.

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