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Original Research Article

Predictors of electrolyte derangement among women with obstructed labor delivering from referral hospitals in rural western Uganda: a multicenter cross-sectional study

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ABSTRACT

Background: Obstructed labor is regarded as one of the major causes of maternal morbidity and mortality, particularly in environments with minimal resources, including Uganda. We aimed to determining the prevalence and predictors of electrolyte derangement among women with obstructed labor delivering from Referral Hospitals in western Uganda.
Methods: We conducted a cross-sectional study from labor suits of Hoima and Fortportal regional referral hospitals from May to August 2023. 295 mothers were consecutively recruited and structured questionnaire was used to get data used for analysis. Descriptive statistics followed by binary logistic regression were conducted to achieve the study objectives using Stata version 14.2.
Results: Out of 295 respondents, 182 (62%) had electrolyte derangement. The most common pattern of electrolyte derangement was hyponatremia 138 (43%) followed by hypocalcaemia 67 (21%). Primary level of education (OR=0.4; 95%CI: 0.199-0.752; p=0.045), fasting in labor (OR=4.2; 95%CI: 2.281-7.996; p=<0.001) and herbal medicine use in labor (OR=4.3; 95%CI: 1.875-9.924, p=0.001) were independently associated with electrolyte derangement.
Conclusions: The prevalence of electrolyte derangement was high compared to the reported national prevalence. Hyponatremia was the most common pattern of electrolyte derangement. Herbal medicine uses in labor, fasting during labor and maternal education were predictive for electrolyte derangement. There is a need for routine assessment of electrolytes in patients with obstructed labor. Attempts to correct hyponatremia should be made in a situation where electrolyte assessment cannot be done.

Keywords: Electrolytes derangement, Predictors, Obstructed labor, Referral hospitals, Uganda

INTRODUCTION

Obstructed labor is defined as the failure of descent of the fetus in the birth canal for mechanical reasons despite good uterine contractions and it is regarded as one of the major causes of maternal morbidity and mortality, particularly in environments with minimal resources, including Uganda.[1,2] Electrolyte derangements are frequently linked to obstructed labor and can result in serious maternal mortalities and are exacerbated by ineffective fluid management during labor and delivery in hospitals due to a range of factors, especially in resource limited environments like Uganda and can lead to fast progression of life threatening electrolyte disorders if not sufficiently managed.[3,4] Electrolyte derangement is a physiological disorder where the serum electrolytes fluctuate from the normal set point to either end of the extremes (either too high or too low).[5] The most typical electrolyte abnormalities include hypo and hyper states of sodium, potassium, calcium, and magnesium.[6]

A prospective observational study on whether or not Hyponatremia complicating labor was conducted at Kalmar County Hospital in Sweden, it was found that the prevalence of electrolyte derangement was 26% among women diagnosed with obstructed labor.[7] Meanwhile in a hospital based cross-sectional study to determine the patterns and levels of imbalance in sodium, potassium, and chloride electrolytes, and the factors associated with each electrolyte imbalance among women with obstructed labor in Mulago hospital in central Uganda, the prevalence of electrolyte derangement was found to be 50.8%.[8] A more recently published study at Mbale Regional Referral in Eastern Uganda regarding Multiple electrolyte derangements among perioperative women with obstructed labor, a total of 209/389 (53.7%) of the participants had electrolyte derangement.[9]

Well established causes of variations from normal fluid and electrolyte set points in obstructed labor include abnormal metabolic activity, excessive uterine contractions, unapproved prolonged fasting, muscular activity, infections with high temperatures and ensuing fluid loss, and maternal exhaustion.[10] According to a study conducted in Niger Delta Region of Nigeria about electrolyte changes in patients with prolonged labor, it was noted that use of oxytocin for labor induction and long periods of fasting had a strong correlation with electrolyte derangement among women with obstructed labor. Noted also was residence in a rural setting and use of herbal medicines administered by traditional birth attendants or family members as the main cause of fluid and electrolyte problems among women with obstructed labor.[3,11] Meanwhile in a study conducted in Uganda's Mulago hospital, women older than 30 years are more likely to develop electrolytes derangement in obstructed labor compared to young women less than 19 years. Additionally, electrolyte derangement in obstructed labor was more likely to develop in Primigravida than multiparous women. It was established that in rural areas, electrolyte derangement is a frequent complication of obstructed labor.[8] In another study regarding multiple electrolyte derangements among perioperative women with obstructed labor that involved secondary analysis of data for 389 patients with obstructed labor at Mbale regional referral hospital in eastern Uganda, it was noted that women who used herbal medicines had 1.6 times the odds of having multiple electrolyte derangements as those who did not use herbal medicines.[9]

METHODS

Authors conducted a multicenter cross-sectional study from labor suits of both Hoima and Fort Portal Regional Referral Hospitals from May 2023 to August 2023. Fort portal regional referral hospital is located in Fort portal tourism city, approximately 271 kilometers mid-west of Uganda's capital Kampala. The facility has a bed capacity of over 450 and provides both outpatient and inpatient services. The maternity ward where this study was conducted comprised of three full time specialists, five residents, one medical officer, four intern doctors and eleven midwives with a bed capacity of about 80 beds. The ward constitutes a prenatal ward, several labor rooms for the women in labor, a postnatal ward, as well as two special cubicals for patients with special conditions such as preeclampsia and those, who for any reason, necessitate closer monitoring. The study participants came from within the city as well as the neighbouring districts of Kabarole, Bundibugyo, Kamwenge, Kasese, Ntoroko, Kyenjojo, Bunyangabu, and Kagadi as well as the Democratic Republic of Congo. Hoima Regional Referral Hospital, is located in Hoima city, approximately 200 kilometers North West of Uganda's capital Kampala. Hoima regional referral hospital has a bed capacity of over 400, provides both out-patients and in-patients services and serves a population of about 573,903 people. The Department of Obstetrics and Gynecology operates on a daily basis, both day and night, with most patients coming in as referrals from lower health facilities and currently is served by five specialists, three residents, two medical officers, seven intern doctors and thirteen midwives with a bed capacity of over 110 beds. The study participants came from the neighbouring areas of Hoima such as Kibale, Masindi, Bulisa, Kiryandongo, Kyankwanzi, Kiboga, and the Eastern parts of the Democratic Republic of the Congo. In addition, both study centers had functional laboratory able to carry out chemistry studies like serum electrolytes using the Cobas technique. We included all women with obstructed labor admitted to the maternity ward of Fortportal and Hoima regional referral hospitals who consented to the study. Patients on medications or conditions that were clearly known to cause electrolyte derangement including metabolic diseases such as diabetes mellitus and preeclampsia were excluded from the study.

Sample size was determined using Daniel's formula as shown below (Daniel, 1999),

$n = \frac{(z_\alpha + z_\beta)^2 p\,(1-p)}{d^2}$ Where; n = Desired sample size, $z\alpha$ = Z-statistic at α= 1.96; 95% level of confidence, z_β = Z-statistic at β= 0.84; p =10.5% based on a study in Uganda[12], d= Level of precision= 0.05

Therefore,

$$n = \frac{(1.96 + 0.84)^2 \times 0.105\,(1 - 0.105)}{(0.05)^2}$$

n =295 participants.

Data collection procedure and electrolyte testing

Following comprehensive explanation and counselling by principal investigator and trained midwives, women with obstructed labor who matched the inclusion criteria were consecutively enrolled until desired sample size was reached. Informed consent was obtained as soon as the diagnosis of obstructed labor was made by the attending clinician followed by administering the structured

questionnaire. An appropriate vein was identified, cleansed at the vein puncture site with a swab of 70% alcohol, and then a hypodermic needle was inserted into the vein. A syringe was used to collect about 3-4 ml of venous blood, which was then transferred to a clean, red-top vacutainer without anticoagulant. This was then sent to the government laboratory of Hoima and Fort portal regional referral hospitals for immediate processing by qualified laboratory technologists within one hour of collection supervised by the principal investigator to avoid inter-observer errors. The electrolytes were analysed using an automated electrolyte analyser machine using the Cobas c311 technique.

Data analysis

Data that were necessary for analysis was compiled in Microsoft excel version 16.0, cleaned, coded and imported to STATA version 14.2. Analysis was done in line with the specific objectives. The prevalence of electrolyte derangement among women with obstructed labor was measured from the total number of women with electrolyte derangement out of total number of women with obstructed labor in the study. This was expressed as percentages and presented using a pie chart. Binary logistic regression was carried out to obtain factors associated with electrolyte derangement among women with obstructed labor. In bivariate analysis, all variables with a p value less or equal to 0.2 were considered for multivariate analysis to control for confounding. Variables with p≤0.05 at multivariate level were considered significant in this study.

RESULTS

Basic characteristics of participants

We enrolled 295 mothers from labor suits of both Hoima and Fortportal regional referral Hospitals with a response rate of 100%. Majority were aged between 20 and 30 years 188 (63.7%), were of rural residence 192 (65.1%), married 235 (79.7%) and attained primary level education 141 (47.8%). Most of them were unemployed 212 (71.9%) and earned on average 200,000 Uganda shillings and below per month. The majority of our respondents lived within a distance of 5 kilometres or less from a health facility 134(52.2%) (Table 1).

Table 1: Bivariate analysis for factors associated with ED among women with obstructed labor at F&HRRHs (n=295).

Variable	Category	Electrolyte derangement		cOR (95%CI)	P value
		Yes (n=182)	No (n=113)		
Age (years)	<20	47 (65.3)	25 (34.7)	0.9 (0.508-1.583)	0.707
	20-30	118 (62.8)	70 (37.2)	1.00	
	31-40	17 (48.6)	18 (51.4)	1.8 (0.864-3.688)	0.118*
Residence	Rural	123 (64.1)	69 (35.9)	0.8 (0.461-1.226)	0.254
	Urban	59 (57.3)	44 (42.7)	1.00	
Marital status	Single	38 (63.3)	22 (36.7)	0.9 (0.509-1.648)	0.770
	Married	144 (61.3)	91 (38.7)	1.00	
Level of education	No formal education	28 (66.7)	14 (33.3)	0.6 (0.265-1.168)	0.121*
	Primary	95 (67.4)	46 (32.6)	0.5 (0.323-0.899)	0.018*
	Secondary and higher	59 (52.7)	53 (47.3)	1.00	
Distance from NHC	≤ 5km	88 (57.1)	66 (42.9)	1.00	
	> 5km	94 (66.7)	47 (33.3)	0.7 (0.415-1.071)	0.094*
Employment status	Employed	46 (55.4)	37 (44.6)	1.00	
	Not employed	136 (64.2)	76 (35.8)	0.7 (0.415-1.164)	0.166*
Monthly income	≤200,000	151 (62.4)	91 (37.6)	0.8 (0.464-1.555)	0.596
	210,000-500,000	31 (58.5)	22 (41.5)	1.00	
Parity	Primipara	113 (66.5)	57 (33.5)	0.6 (0.386-0.999)	0.049*
	Multipara	69 (55.2)	56 (44.8)	1.00	
Duration of labor	<18 hours	144 (68.6)	66 (31.4)	1.00	<0.001*
	≥18 hours	38 (44.7)	47 (55.3)	2.7 (1.609-4.527)	
Type of labor onset	Spontaneous	132 (59.2)	91 (40.8)	1.00	
	Induced	50 (69.4)	22 (30.6)	0.6 (0.362-1.126)	0.121*
Augmentation of labor	Yes	45 (71.4)	18 (28.6)	0.6 (0.315-1.057)	0.075*
	No	137 (59.1)	95 (40.9)	1.00	
IV fluid administration	Yes	101 (72.7)	38 (27.3)	1.00	<0.001*
	No	81 (51.9)	75 (48.1)	2.5 (1.511-4.008)	
Oral fluid restriction	Yes	21 (84.0)	4 (16.0)	0.3 (0.094-0.842)	0.023*
	No	161 (59.6)	109 (40.4)	1.00	

Continued.

Variable	Category	Electrolyte derangement		cOR (95%CI)	P value
		Yes (n=182)	No (n=113)		
Duration since last meal	<8hours	142 (74.7)	48 (25.3)	1.00	
	≥ 8hours	40 (38.1)	65 (61.9)	4.8 (2.881-8.022)	<0.001*
Herbal medicine use in labor	Yes	122 (54.0)	104 (46.0)	5.7 (2.690-12.005)	<0.001*
	No	60 (87)	9 (13)	1.00	

*p≤0.2, cOR =crude Odds Ratio, CI =Confidence Interval, IV= Intravenous Fluid, ED =Electrolyte Derangement, NHC=Nearby Health Centre, KM=Kilometer

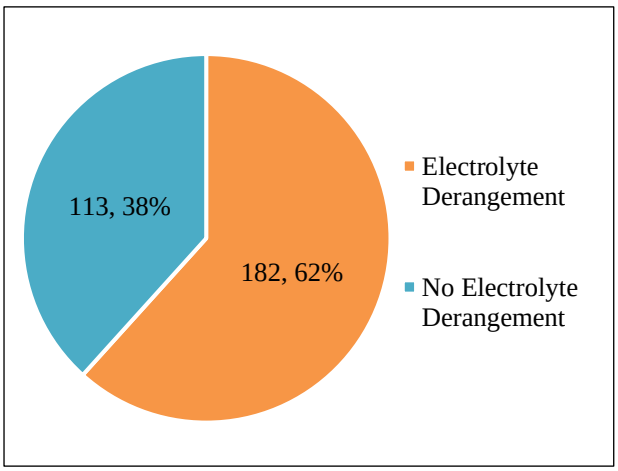

Figure 1: Prevalence of electrolytes derangement among women with obstructed labor at fort portal and hoima RRHs.

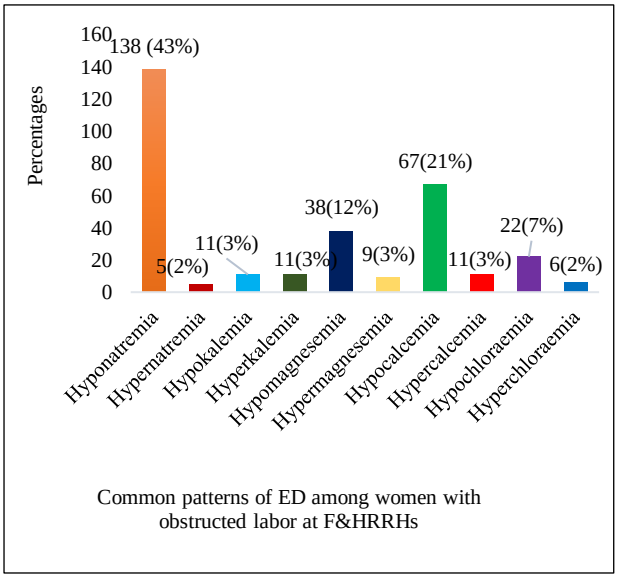

Figure 2: Patterns of electrolytes derangement among women with obstructed labor at fort portal and hoima RRHs.

Prevalence of ED among women with obstructed labor at F&HRRHs

Of 295 mothers with obstructed labor, the overall prevalence of electrolyte derangement was 182 (62%). 113 (38%) had no electrolyte derangement. This is presented in Figure 1. The most common pattern of electrolyte derangement among women with obstructed labor at F&HRRHs was hyponatremia, 138 (43%) followed by hypocalcaemia, 67 (21%). This is presented in (Figure 2).

Associated factors of electrolytes derangement among women with obstructed labor at F&HRRHs

Bivariate analysis for factors associated with electrolyte derangement among mothers with obstructed labor revealed that old maternal age, primary level of education, distance from nearby health facility more than 5 Kilometers, no employment status, low parity, longer duration of labor, induction of labor, augmentation of labor, IV fluid administration, oral fluid restriction), duration since last meal of more than 8 hours, and herbal medicine use in labor were significant factors (Table 1).

Multivariate analysis (Table 2) was further conducted and finally showed that primary level of education (OR=0.4; 95%CI: 0.199-0.752; p=0.045), labor duration since last meal of more or equal to 8 hours (OR=4.2, 95%CI: 2.281-7.996; p≤0.001) and herbal medicine use in labor (OR=4.3; 95%CI:1.875-9.924, p=0.001) were independently associated with electrolyte derangement among women with obstructed labor at Fortportal and Hoima regional referral hospitals. It was precisely noted that primary level of education was protective for electrolyte derangement (OR=0.4; 95%CI: 0.199-0.752; p=0.045). These women were 0.4 times less likely to have electrolyte derangement. It was also observed that women with obstructed labor who had last meal in more or equal to 8 hours had 4-fold the odds of having electrolyte derangement (OR=4.2; 95%CI: 2.281-7.996; p≤0.001). Likewise, women with a history of herbal medicine use in labor were 4 times the odds of suffering electrolyte derangement (OR=4.3; 95%CI: 1.875-9.924, p=0.001).

Table 2: Associated factors of electrolytes derangement among women with obstructed labor at F&HRRHs (n=295).

Variable	Category	cOR (95%CI)	P value	aOR (95%CI)	P value
Age (years)	<20	0.9 (0.508-1.583)	0.707	0.9 (0.469-2.282)	0.931
	20-30	1.00			

Continued.

Variable	Category	cOR (95%CI)	P value	aOR (95%CI)	P value
	31-40	1.8 (0.864-3.688)	0.118*	1.0 (0.361-2.272)	0.835
Level of education	No formal education	0.6 (0.265-1.168)	0.121*	0.5 (0.176-1.272)	0.138
	Primary	0.5 (0.323-0.899)	0.018*	0.4 (0.199-0.752)	0.045**
	Secondary and higher	1.00			
Distance from NHC	≤5 km	1.00			
	>5 km	0.7 (0.415-1.071)	0.094*	1.2 (0.639-2.287)	0.559
Employment status	Employed	1.00			
	Not employed	0.7 (0.415-1.164)	0.166*	0.8 (0.426-1.593)	0.566
Parity	Primipara	0.6 (0.386-0.999)	0.049*	0.6 (0.314-1.201)	0.154
	Multipara	1.00			
Duration of labor	<18hours	1.00			
	≥18hours	2.7 (1.609-4.527)	<0.001*	1.7 (0.869-3.194)	0.124
Type of labor onset	Spontaneous	1.00			
	Induced	0.6 (0.362-1.126)	0.121*	0.8 (0.403-1.617)	0.546
Augmentation of labor	Yes	0.6 (0.315-1.057)	0.075*	0.8 (0.339-1.7)	0.548
	No	1.00			
IV fluid administration	Yes	1.00			
	No	2.5 (1.511-4.008)	<0.001*	1.8 (0.931-3.567)	0.080
Oral fluid restriction	Yes	0.3 (0.094-0.842)	0.023*	1.2 (0.326-4.740)	0.749
	No	1.00			
Duration since last meal	<8hours	1.00			
	≥ 8hours	4.8 (2.881-8.022)	<0.001*	4.2 (2.281-7.996)	<0.001**
Herbal medicine use in labor	Yes	5.7 (2.690-12.005)	<0.001*	4.3 (1.875-9.924)	0.001**
	No	1.00			

*p≤0.2, **P≤0.05, cOR=crude Odds Ratio, aOR =adjusted Odds Ratio, CI =Confidence Interval, IV= Intravenous Fluid, ED =Electrolyte Derangement, NHF=Nearby Health facility, KM=Kilometer

DISCUSSION

Our study has noted the prevalence of electrolyte derangement among women with obstructed labor to be 62%. Although very few studies have been conducted regarding electrolyte dysfunction world over, a few available study reports have indicated a comparatively lower prevalence than ours; for instance the one conducted in Sweden indicated a prevalence of 26%, a study in Nigeria showed the prevalence of 54.1%, the one done at Mulago Hospital Uganda showed the prevalence of 50.8% as well as that conducted at Mbale regional referral hospital in Uganda showed a prevalence of 53.7%.[3,8,9,13] This could be explained by the differences in the number of electrolytes analysed. Our study assessed many electrolytes (up to five electrolytes) compared to the ones assessed by the mentioned previous researchers above. This could have enhanced the chances of finding at least a deranged electrolyte in the patients assessed and hence the large number.

According to the current study, hyponatremia was the common pattern of electrolyte derangement followed by hypocalcaemia. The study has revealed that 138 (43%) and 67 (21%) of the 295 participants had hyponatremia and hypocalcaemia respectively. We found this result comparable with the one reported in the USA and that reported in Sweden with hyponatremia as the most common pattern of electrolyte derangement among women with obstructed labor.[13,14] Our findings however differed from that of Yakasai and colleagues in Nigeria (potassium), Ekanem and colleagues in Nigeria (hypernatremia and hyperkalaemia), Ritah et al (hypobicarbonatemia) in Mbale regional referral hospital in Uganda as well as that of Chebet and Izudi in Mulago hospital also in Uganda (chloride imbalance followed by potassium imbalance).[8,9,11,15] Interestingly, as opposed to our study, sodium imbalance was the least frequent in the study done in Mulago hospital.[8] This therefore justifies the importance of assessing all women with obstructed labor for the presence of electrolyte derangement, and the specific electrolyte involved at that particular time for appropriate patient management based on such evidence-based variation in the electrolyte findings as documented here.

Our study found a significant likelihood of electrolyte derangement among women with obstructed labor with herbal medicine use in labor. Women who reported having used herbs during labor were 4-fold likely to have deranged electrolytes (OR=4.3; 95%CI: 1.875-9.924, p=0.001). This observation was in agreement with the findings of Ekanem et al in Nigeria where the use of herbal medicines administered by traditional birth attendants or family members was the main cause of fluid and electrolyte problems among women with obstructed labor.[11] Consistent findings were also noted with the study done from Mbale Regional Referral Hospital in which, women who used herbal medicines had 2 times the odds of having electrolyte derangements as compared to those who

did not use herbal medicines.[9] As suggested, over the past few years, the public interest in herbs as an alternative medical approach has grown and become more appealing.[16] The concerns over safety and unclear side effect profiles of several herbs remain a challenge. Most herbal complexes have been noted to cause electrolyte derangement, for instance, herbal complexes containing liquorice have been shown to induce hypokalaemia and other forms of electrolyte derangement among others.[17] It is therefore possible that herbs used in labor have such complexes that could pose electrolyte impairment in the user.

The current study also established an association between duration since last meal with electrolyte derangement in obstructed labor. Women with obstructed labor who reported a duration of more or equal to 8 hours since their last meal were 4 times the odds of having electrolyte derangement (OR=4.2; 95%CI: 2.281-7.996; p≤0.001). A similar observation had been reported in Nigeria and in Sweeden who noted that long periods of fasting had a strong correlation with electrolyte derangement among women with obstructed labor.[11,13] Since we take most of our electrolytes from food, fasting means less access to electrolytes and hence predisposing to electrolyte changes in the body.

This study noted a protective effect of education and electrolyte derangement in women with obstructed labor. The study specifically noted that primary level of education was protective for electrolyte dysfunction (OR=0.4; 95%CI: 0.199-0.752; p=0.045). These women were 0.4 times less likely to have electrolyte derangement. This is because maternal education has been associated with changes in attitudes, beliefs and practices, autonomy and decision-making, and control over their fertility behavior, all of which enhance healthcare-seeking.

This study did not establish an association between labor inductions with electrolyte derangement in obstructed labor. However other researchers such as Chebet and Izudi in Uganda and Ekanem et al in Nigeria found that the use of oxytocin for labor induction had a strong correlation with electrolyte derangement among women with obstructed labor.[8,11] Women whose labor was induced are more likely to have intense uterine contractions and some labor-inducing agents may cause side effects like fever, vomiting, diarrhea and sweating which may alter the body's electrolyte composition. This could explain why women who underwent labor induction were more likely to get electrolyte derangement.

This study has few limitations. This study was a multicenter study which was able to assess several electrolytes (up to five electrolytes) compared to most previous studies. This put us in a better position to ascertain the prevalence of electrolyte derangement at this facility. This being a cross-sectional study, it could not establish a causal relationship. Also, the findings could not be generalized to the whole population since this was institutional-based. Future population-based studies are suggested.

CONCLUSION

The prevalence of electrolyte derangement at F&HRRHs was high compared to the reported national prevalence. Hyponatremia is the most common pattern of electrolyte derangement among women with obstructed labor at F&HRRHs. Herbal medicine use in labor, fasting during labor and maternal education are predictive for electrolyte derangement among women with obstructed labor at F&HRRHs. There is a great need for routine assessment of electrolytes in patients with obstructed labor by the attending clinicians at these facilities. Attempts to correct hyponatraemia should be made in a situation where electrolyte assessment cannot be done by the attending clinicians at these facilities. There is a need for health authorities in F&HRRHs to sensitize the public and healthcare workers on the predictor factors for electrolyte derangement for prevention.

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