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Acceptability and use of iron and iron-alloy cooking pots: implications for anaemia control programmes

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Abstract

Objective: To evaluate the acceptability of iron and iron-alloy cooking pots prior to an intervention trial and to investigate factors affecting retention and use.
Design: Pre-trial research was conducted on five types of iron and iron-alloy pots using focus group discussions and a laboratory evaluation of Fe transfer during cooking was undertaken. Usage and retention during the subsequent intervention trial were investigated using focus group discussions and market monitoring.
Setting: Three refugee camps in western Tanzania.
Subjects: Refugee health workers were selected for pre-trial research. Mothers of children aged 6–59 months participated in the investigation of retention and use.
Results: Pre-trial research indicated that the stainless steel pot would be the only acceptable type for use in this population due to excessive rusting and/or the high weight of other types. Cooking three typical refugee dishes in stainless steel pots led to an increase in Fe content of 3·2 to 17·1 mg/100 g food ($P < 0·001$). During the trial, the acceptability of the stainless steel pots was lower than expected owing to difficulties with using, cleaning and their utility for other purposes. Households also continued to use their pre-existing pots, and stainless steel pots were sold to increase household income.
Conclusions: Pre-trial research led to the selection of a stainless steel pot that met basic acceptability criteria. The relatively low usage reported during the trial highlights the limitations of using high-value iron-alloy cooking pots as an intervention in populations where poverty and the availability of other pots may lead to selling.

Keywords
Iron cooking pots
Acceptability
Stainless steel
Refugees

Fe deficiency and Fe-deficiency anaemia continue to be major public health problems, particularly in refugee populations where food insecurity, associated with displacement and conflict, often place additional strains on nutritional reserves[1,2]. Currently, the most common strategies for reducing Fe deficiency and Fe-deficiency anaemia are Fe supplementation and food fortification. Both strategies have been shown to be highly successful but have various limitations due to logistical constraints, costs and lack of adherence[3–5].

Since the late 1990s, various studies have demonstrated the efficacy of consuming food prepared in cast iron cooking pots in reducing Fe-deficiency anaemia. These studies have demonstrated a significant improvement in the Fe status and Hb values of children and adults who consume food cooked in such pots[6–9], but no population-based trials have demonstrated the effectiveness of such a strategy.

Based on the available efficacy data, the World Food Programme (WFP) and the United Nations High Commissioner for Refugees (UNHCR) jointly funded an intervention trial to evaluate the impact of supplying iron or iron-alloy cooking pots on Fe deficiency and anaemia in a food aid-dependent population. Results from the community intervention trial have recently been published and indicate no evidence of improved Fe status or reduced anaemia[10]. While the pots were initially distributed to all refugee households in the intervention camp, by 6 months 19 % of households had disposed of the pot and by 12 months this figure had risen to 39 %. Of the households that retained pots only about 44 % used them on a daily basis for cooking[10]. The current paper

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presents data from the pre-trial evaluation of the various types of cooking pot and then explores reasons for the low retention, use and acceptability of the iron alloy (stainless steel) cooking pot reported during the intervention trial.

Methods

Study sites

During the study, which took place from 2000 to 2003, there were five refugee camps in Kibondo district of western Tanzania. All of the camps were formed after an outbreak of ethnic conflict between Hutu and Tutsi groups in Burundi, caused an influx of Hutu refugees into the Kigoma region of western Tanzania. Mkugwa Camp (population 1425; established 1993) was a small and geographically isolated camp and was selected as the site for the pre-trial research study to evaluate the acceptability of various cooking pots. For the intervention trial, Nduta Camp (population 48 307; established 1996) was selected as the intervention camp and Mtendeli Camp (population 41 235; established 1996) was the control camp. All three had comparable health, nutrition and socio-economic status[11].

Pre-trial evaluation of different types of iron and iron-alloy cooking pots

In January 2000, pre-trial research was conducted with the objectives of assessing the acceptability of different types of cooking pot and their efficacy in transferring Fe to food during cooking. There were two components of the pre-trial evaluation: (i) focus group assessment of user perceptions; and (ii) laboratory assessment of Fe transfer during the cooking of meals typical of refugees from the camps in the region. The five types of iron and iron-alloy cooking pots evaluated were cast iron, mild steel, treated blue steel and untreated blue steel, and, during the laboratory evaluation, an additional stainless steel pot was included. Aluminium cooking pots were used as the control, having zero Fe content and being the standard type of cooking pot distributed by UNHCR in the Kibondo refugee camps. All five types of pot came in 5- and 7-litre sizes (Fig. 1).

Focus group assessment of user perceptions

Workers from the community health clinic in Mkugwa Camp were approached as potential focus group participants. This group was selected as it was considered likely that they would be interested in the topic under investigation and prepared to attend repeated focus groups, and they could be conveniently sampled. A range of employees, including midwives, lab workers and cleaners, were recruited. Where the subject was not the main cook in the family they were asked to nominate this person as a replacement to attend the groups. This resulted in ten of the employees being replaced by their wives and only two of the group participants ended up being male. Three focus groups were formed with six, eight and nine members, respectively. The twenty-three workers or their wives were each given one of five types of cooking pot (cast iron, mild steel, treated blue steel, untreated blue steel or aluminium) to use for 3 d. Different types of pot were distributed to members of the same group so they could compare and contrast their experiences during subsequent discussions. The participants were asked to return the pot at the end of the 3 d period and exchange it for another type. Each time a participant returned a pot they were asked to participate in a focus group to talk about their experiences with the pots. Four focus group discussions were held with members of groups 1 and 2, but only three group discussions were held with members of group 3 due to lack of time. Nine of the twenty-three group members had stopped attending by the last focus group meeting. Stainless steel cooking pots were not evaluated in this part of the study.

Laboratory assessment of Fe transfer during cooking

Each of three different meals was cooked three times, using distilled water, in each type of cooking pot. The meals were selected following qualitative field work that identified commonly used recipes and utilized samples of ingredients collected from the camps in Tanzania. The three meals were: (i) CSB, a corn–soya blend with added vitamins and minerals; (ii) *ugali*, a boiled maize gruel; and (iii) yellow bean and cassava stew.

At the end of cooking, homogenised samples were frozen at −20°C and freeze-dried over 7 d. When dried, the samples were ground using an acid-washed pestle and mortar, and weighed into plastic bags. Sub-samples of freeze-dried foods were ashed in a muffle furnace at 480°C for 48 h. Samples of National Institute of Standards and Technology standards containing certified values for Fe from cereals and total diet were ashed at the same time. Sub-samples of the ash were taken up in 5 % (w/v) HCl and measurement of total Fe performed using an atomic absorption spectrophotometer (Perkin Elmer 3300; Perkin-Elmer Inc., Waltham, MA, USA). The Fe content of the three meals was averaged to obtain the total Fe content. The Fe content of meals cooked in an aluminium cooking pot was subtracted from the total Fe content to obtain an estimate of the quantity of Fe transferred from the cooking pots during cooking. Meal preparation and Fe analysis were conducted at the Institute of Food Research, Norwich, UK.

Selection and distribution of cooking pots for the intervention trial

Following analysis of the results of the pre-trial formative research, it was decided to conduct the intervention trial using stainless steel cooking pots. These were distributed to all households in the intervention camp in February 2002. All households received a 5-litre stainless steel pot which had a flat base, two movable non-insulated, non-riveted handles at the side, and a lid with a non-insulated, non-riveted

Fig. 1 A selection of iron and iron-alloy cooking pots after use in the pre-trial evaluation and the stainless steel pot (bottom), which was distributed in the intervention trial. Different sizes are shown: 5-litre cast iron and stainless steel, and 7-litre blue steel, mild steel and aluminium cooking pots. The treated blue steel cooking pot is similar in appearance to the blue steel pot and is not shown in this photograph

handle. The pot was intended for cooking beans, peas and other legumes for families of one to ten persons. Cooking pots already in use in households in the camp (aluminium or locally made clay pots) were not removed.

Because the aim of the trial was to assess the programme effectiveness of stainless steel cooking pot distribution in resource-poor refugee settings, the social mobilization campaign undertaken prior to pot distribution was limited to that thought feasible in similar settings. The core components of the campaign included: (i) distribution of posters with text containing key messages about the benefits of the pot, how to use it, what to cook in it and the importance of feeding children food cooked in the pots; (ii) meetings with camp leaders to explain the programme; and (iii) limited training for camp community workers on the benefits of cooking in the stainless steel pot.

Investigation of use and retention during the intervention trial

Market monitoring was undertaken during the first 2·5 months of the project to assess the number of stainless steel pots being sold and market prices in local markets: Nduta market (located within the intervention camp), and Kibondo town market and Biturana common market, which are located outside the refugee camps.

Three household surveys were conducted in both the intervention and control camps among children aged 6–59 months and their mothers at baseline (December 2001, just prior to distribution of the cooking pots) and at 6 months and 12 months after distribution. Detailed methods and results are reported elsewhere[10].

Eight post-intervention focus group discussions were conducted immediately after the 12-month survey in the

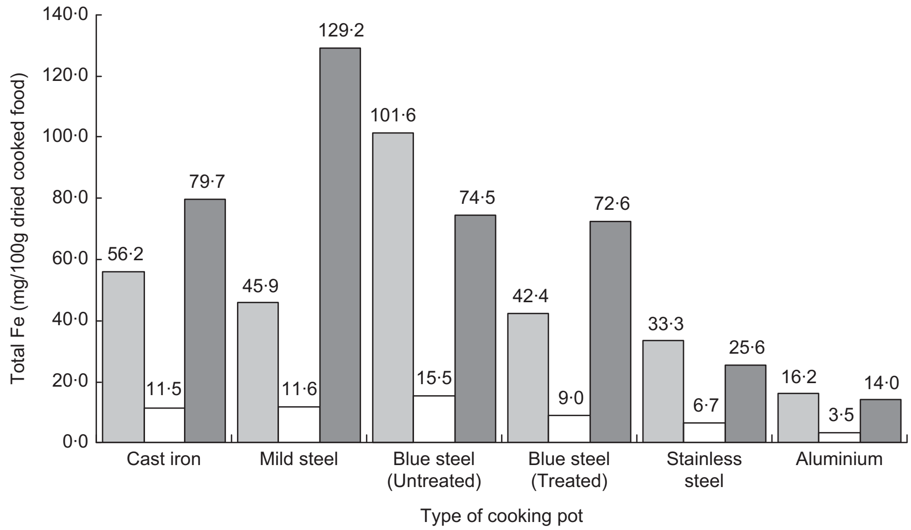

Fig. 2 Iron content of meals (□, corn–soya blend; □, *ugali*; □, bean-and-cassava stew) cooked in different types of cooking pot

intervention camp. Each group comprised ten to twelve women and men and the discussions lasted 1·5 to 2 h. Interviews with key informants and discussions with agencies operating in the camps were also undertaken. The main objectives of the focus group discussions were the following: (i) to assess perceptions and knowledge about the use and purpose of the cooking pots; (ii) to determine reasons for selling or retaining the cooking pots; (iii) to explore the impact of the cooking pots on current cooking practices and consumption of food; (iv) to identify perceptions about the suitability of the pot design; (v) to assess other uses of the pots; and (vi) to assess perceptions about the impact of the pots on the use of firewood and consumption of fuel.

Results

Pre-trial evaluation of different types of iron and iron-alloy cooking pots

Focus group participants, who used any of four types of iron or iron-alloy cooking pot (cast iron, mild steel, blue steel or treated blue steel), complained that rust stained their food and added a bad taste. Because of rust, food overnight stored in iron-containing pots would become inedible by morning. There was also concern that rust caused cancer or was a poison sent by enemies. Generally, participants did not feel that there was much difference between the blue steel (treated and untreated) and the mild steel pots.

Participants who used mechanisms to prevent rusting, such as putting pots on the fire for a few seconds to dry after washing, found that their pots rusted less. They were less fearful about the health implications. Researchers suggested that rubbing a small amount of oil on the pots also helped prevent rusting; however, participants said they did not have enough cooking oil to do this.

The cast iron pot was unpopular because it was very heavy. Only two out of the twenty-three participants agreed to try it. Those who did found that rusting was also a problem with this type of cooking pot. Overall, participants reported that none of the iron and iron-alloy cooking pots tested were acceptable for routine use. The aluminium pot was preferred because it was light and easy to clean.

Because of the unexpectedly low acceptability of all cooking pots assessed during in the focus groups, a rust-resistant stainless steel cooking pot was also included in the laboratory evaluation of Fe transfer during cooking. Cooking in cast iron, mild steel, treated blue steel and untreated blue steel pots all contributed significant amounts of Fe to the meals ($P < 0{\cdot}05$; t test), except for bean-and-cassava stew cooked in a mild steel pot and CSB cooked in a untreated blue steel pot (Fig. 2). In these cases the elevation in Fe content appeared substantial but was not statistically significant, apparently due to a high inter-sample CV (>50 %) caused by uneven and blotchy rusting of the pots. In all other analyses the inter-sample CV was <20 %.

Cooking food in a stainless steel cooking pot led to a lower but significant increase in the Fe content of *ugali*, CSB and bean-and-cassava stew (3·2, 17·1 and 11·6 mg/100 g) in comparison with foods cooked in aluminium pots ($P < 0{\cdot}01$; t test). Regardless of the pot used, CSB and bean-and-cassava stew contained significantly higher levels of Fe than *ugali*.

Selection and distribution of cooking pots for the intervention trial

Based on the findings from the focus group assessment and the laboratory measurement of Fe transfer, it was decided that stainless steel pots should be used in the intervention trial. The unacceptable level of rusting and high weight of the other types, combined with the favourable Fe transfer characteristics of the stainless steel

Table 1 Focus group findings: problems with the design of the stainless steel cooking pot*

Hard to clean	A shortage of soap and increased risk of burning food made these pots very difficult to clean
Size	The pot was perceived as only being big enough for family size one to five rather than one to ten. The pot size was also too small to cook a range of different foods. Refugees wanted a multipurpose pot
Difficult to use on a three-stone hearth	The narrow base of the pot made it harder to balance the pot on a three-stone hearth
Does not fit pre-existing improved stoves	Redeso (the camp environment agency) estimated that approximately 50 % of households in the intervention camp had improved stoves. Most of these stoves, however, were built to fit bigger pots and needed modification or rebuilding to use the stainless steel pot. Using a small pot on an improved stove designed for another type of pot caused the chamber of some stoves to break
Fragile handles, particularly on the lid	Several participants mentioned that the handles on their pot, particularly the lid handle, had broken off
No rim	If the handles break, the lack of a rim makes the pot difficult to carry or remove from the stove
Shape	The pot is considered too deep. Wider shallower pots are more desirable as they fit most improved stoves and can balance better on three-stone hearths
Weight	The pot is considered too light to prepare food items like *ugali*

*Ranked in order of the number of people who gave each response.

Table 2 Focus group findings: beneficial features of the design of the stainless steel cooking pot*

Lid design	The lid fits the pot well and prevents vermin from getting into the pot's contents. The lid also keeps the food hot and helps cook food more quickly than does an aluminium or clay pot
Handle design	The handles are not riveted, which means there are no holes through which water can enter or insects can get into the pot
Health benefits	Although most participants were confused about the connection between stainless steel and anaemia, most of the people who used the pot daily viewed cooking with the pot as beneficial
Versatile uses	Aside from cooking, the pot was useful for serving food, storing water, and for bathing and washing
Fuel-efficient	Most focus group participants said that the stainless steel pot used much less fuel. Restrictions on collecting firewood in the intervention have made fuel efficiency a greater priority
Appearance	Many participants mentioned that the appearance of the pot made it very suitable for serving food and local beer, especially when they had guests

*Ranked in order of the number of people who gave each response.

cooking pot, made it the best option for distribution in the planned intervention trial. Concerns over exceeding the safe upper limits for Fe consumption and the long-term risk of developing Bantu siderosis also precluded the use of the other pot types. Unfortunately, time and funding did not permit a repeat of the acceptability field study on the stainless steel cooking pot.

Investigation of use and retention

During the intervention trial, focus group discussions revealed that the stainless steel pots were used for many activities other than cooking, including storing drinking water, storing important documents such as ration cards, serving food, and transporting food and water. Resistance to rodent entry was a highly valued feature that gave the stainless steel pot a unique advantage for many of these applications. Because households had retained their previous clay and aluminium cooking pots, they had a choice about which pot to use for cooking and which containers to use for storage.

Focus group participants who used the stainless steel pot for cooking agreed that all family members, including children greater than 4 months of age, ate food prepared in the stainless steel pot. The first meal of the day was usually composed of porridge made of maize or millet, and the second meal included *ugali* and vegetables (either beans or peas). The majority of households that used the stainless steel pot used it to cook legumes and CSB. For some people the design of the pot limited its use and acceptability. In Table 1, these design flaws are ranked in order of the number of people who gave each response. Significant advantages of the stainless steel pot are identified in Table 2, ranked again in order of the number of people who gave each response.

Several focus group participants reported being suspicious about the motives behind the pot distribution. Many believed the rumours, reportedly initiated by market traders, that the pots were harmful. On the other hand, participants who had heard of the pots and knew of their potential health benefits reported retaining their pots. However, focus group discussions revealed that while people had an idea that the pots were associated with health benefits, they did not understand why it was important to cook in the pot. Many people thought that merely serving food in the pot would be just as beneficial as cooking it in the pot. While women were the ones who did most of the household cooking, focus groups revealed that it was generally men who collected the pot from the distribution point and, as a result, women had received less information about the pot or its benefits. Some women reported having seen information posters in the camp but remarked that they were unable to read them.

Investigators were concerned that the risk of Bantu siderosis (a form of Fe overload) in males might be exacerbated by consumption of beer brewed in pots containing iron or iron alloy. However, findings from the

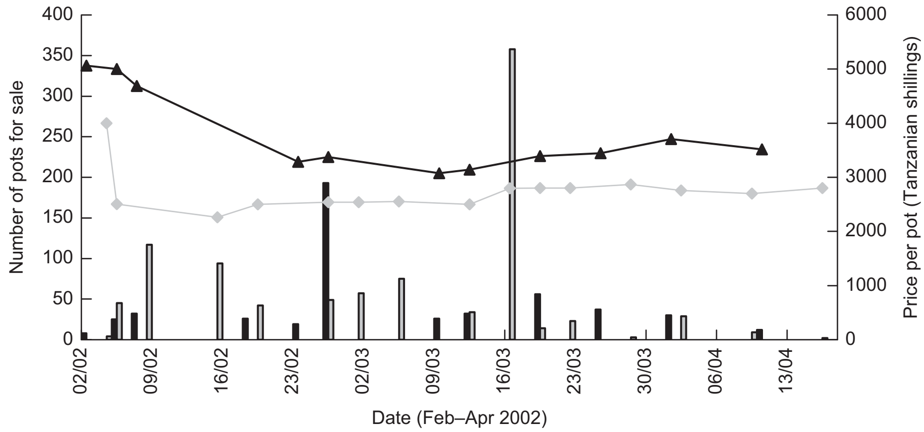

Fig. 3 Number of stainless steel pots offered for sale (■, Kibondo market; □, Nduta and Biturana markets combined) and mean price per pot (—▲—, Kibondo market; —◆—, Nduta and Biturana markets combined)

pre-intervention focus groups indicated that while most of the beer consumed in the intervention camp was home-made, stainless steel pots would probably not be used for brewing beer because of their small size. As confirmation, none of the male participants in the post-intervention focus groups said they brewed beer in the pots, but many used them for serving beer. This would be unlikely to increase the Fe content of the beer, as it would not be stored in the pot for extended periods of time.

Most focus group participants who used the pot reported that their cooking practices had changed. Food burned more easily in the stainless steel pots than in aluminium or clay pots, particularly when used on an improved stove rather than a traditional three-stone hearth. Instead of leaving the food to cook slowly while working on other chores in the house, women had to focus exclusively on cooking, albeit for a shorter length of time. Women reported cooking beans for about 15 min less than they would take using the aluminium or clay pots. Some people reported trying to cook with less firewood or on a three-stone hearth rather than the improved cooking stove to reduce the amount of heat to which the pot was exposed. Other solutions identified to prevent burning the food included cooking without the lid on, stirring frequently and adding plenty of water.

Results from the focus group discussions and direct observations suggested that the stainless steel pots were more fuel-efficient than aluminium pots. Most people in the focus groups estimated that their consumption of firewood had decreased by about one-third since they had started using stainless steel pots.

The stainless steel cooking pots were seen as a non-essential but valuable item because most households still had the aluminium or clay pots used prior to the trial. One of the principal reasons for selling the pot shortly after the distribution was poverty; another was pressure to sell from local traders. Observations in local markets, where the pots appeared for sale, indicated that the price of the pots was highest in the first few days after distribution after which it dropped and eventually stabilized at around 3000–3500 Tanzanian shillings (€3·71–4·33) per pot (Fig. 3). Sale of pots continued during the three months of market monitoring. Selling of the pots later in the year was reported by focus group participants to be a coping strategy to make up for cuts in food rations in the camp and increasing restrictions on the movement of the refugees and their ability to earn money as casual labourers. This was particularly apparent for poorer households. It was these economic factors, rather than misconceptions about the pots, which appeared to be the main motive for selling later in the follow-up period.

Discussion and recommendations

The pre-trial research we conducted helped to identify serious problems with the materials and design of iron and iron-alloy cooking pots used in previous studies[6,7,9,12]. These problems are, to our knowledge, largely specific to the population included in our evaluation. Nevertheless, they would have had serious consequences if one of these types of pot had been used in a large-scale procurement and distribution programme. Extensive rusting, the potential for excessive Fe intake and high unit weight could have made the distribution of cast iron, mild steel, treated blue steel or untreated blue steel cooking pots a costly waste of resources.

A previous evaluation of acceptability in Malawi, published after the initiation of the present study, adopted a quantitative approach in which serial questionnaires were used to assess changes in the acceptability of cast iron cooking pots over time. Despite some differences in context and methods the study reached similar conclusions to our own, citing rusting and excessive weight as reasons for the low acceptability of cast iron pots[13]. A systematic review of randomised trials that used cast iron pots noted that compliance with pot use varied considerably between countries[8]. This depended on the user group, familiarity with iron pots, size of the pot, and whether the pot was introduced as an extra or replacement. Despite publication of four randomised control trials, our paper is only the second looking at acceptability in detail. It is also the first that has focused on a comparison between different types of cooking pot and assessed the reasons for low compliance with the use of stainless steel pots.

Our pre-trial findings pointed us to the use of a 5-litre stainless steel cooking pot in the intervention trial. While this product was shown by our laboratory evaluation to deliver safe but substantial quantities of Fe, our post-trial evaluation indicated that there were several features of its design that could have been improved. This may have accounted in part for the apparently high levels of sale in local markets and the lower levels of retention and use than we had hoped for[10]. These factors, in turn, may have contributed to the lack of impact of the stainless steel cooking pots on Fe deficiency that is reported separately[10].

Several design flaws affecting the acceptability of the stainless steel pots were not recognised during the pre-trial research, as these pots were not included in the focus group evaluation of user perceptions. The pre-trial evaluation of pots was very useful in identifying the possible reasons for resistance to various types of iron and iron-alloy cooking pots, but the findings had limited applicability to the stainless steel pot that was selected. Selecting a pot that better met local requirements would have helped increase its use, but a balance would have to be struck between conflicting design requirements.

A suitable cooking pot for this refugee community would be stainless steel; slightly heavier and larger than the pot tested; have larger, non-riveted handles on the sides of the pot and the lid; have a rim around the top of the pot to assist with carrying and transporting; have a lid that fits tightly inside the pot; be designed with a flat base; and be easier to clean.

Many of the problems we discovered were due to introducing a cooking pot where other pots already existed. If the stainless steel pots were part of the standard issue in a newly displaced population, there would almost certainly not be the same level of suspicion as there was during the trial. If stainless steel pots are introduced to refugee communities that already have other types of cooking pots, it might be preferable to replace the previously issued pot with the new pot. Consideration could also be given to introducing the pots into local markets at the same time to lower their price.

Overall, we found that the effort invested in pre-trial research was crucial in preventing distribution of undesirable products and selecting the best available product option. However, it was still inadequate to fully predict how beneficiaries would use the distributed cooking pot. The data gathered on the use and acceptability of the stainless steel cooking pots during the trial helped suggest possible reasons for the lack of a nutritional impact of the intervention. Acceptability to consumers and studies of usage should be an integral part of any research seeking to introduce novel products or technologies in improving public health[13]. In situations such as refugee camps, where the consumer may have little or no market power or choice, these studies are particularly important.

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