Developing a patient-centered community-based model for management of multi-drug resistant tuberculosis in Uganda: a discrete choice experiment

Rita Makabayi-Mugabe1,2*, Joseph Musaazi1, Stella Zawedde-Muyanja1,2, Enock Kizito2, Hellen Namwanje2, Philip Aleu2, Danielle Charlet3, Debora B. Freitas Lopez3, Haley Brightman3, Stavia Turyahabwe4 and Abel Nkolo2

Abstract

Background: The advent of all-oral regimens for the management of multi-drug resistant tuberculosis (MDR-TB) makes the implementation of community-based directly observed therapy (CB-DOT) a possibility for this group of patients. We set out to determine patient preferences for different attributes of a community-based model for the management of MDR-TB in Uganda.

Methods: The study was conducted at five tertiary referral hospitals. We used a parallel convergent mixed methods study design. To collect quantitative data, we conducted a discrete choice experiment (DCE) with three different attributes of community-based care (DOT provider, location of care, and type of support) combined into eight choice sets, each with two options and an opt-out. We elicited patient reasons for selection of each choice set using qualitative methods. We fitted a mixed logit choice model to determine patient preferences for different attributes of community-based care and estimated the relative importance of each attribute using the range method. and used deductive thematic analysis to understand the reasons for the choices made.

Results: From December 2019 to January 2020, we interviewed 103 patients with MDR-TB. We found that all the three attributes considered were important predictors of choice. The relative importance of each attribute was as follows; the type of additional support (relative importance 36.2%), the location of treatment delivery (33.5%), and the type of DOT provider (30.3%). Participants significantly valued treatment delivered by community health workers (CHWs) or expert clients over that delivered by a family member, treatment delivered at home over that delivered at the workplace, and monthly travel vouchers as the form of additional support over phone call or SMS reminders. Subgroup analyses showed significant differences in preference across HIV status, age groups and duration on MDR-TB treatment, but not across gender.

The preferred model consisted of a CHW giving DOT at home and travel vouchers to enable attendance of monthly clinic follow-up visits to tertiary referral hospitals for treatment monitoring. Qualitative interviews revealed that

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Background
Multi-drug resistant tuberculosis (MDR-TB), defined as resistance to both isoniazid and rifampicin, the two major first line anti-TB medicines, threatens global TB control efforts and remains a major public health concern in many countries [1]. Globally, case detection and treatment success rates for MDR-TB are suboptimal. In Uganda, only 64% of those started on treatment for multi-drug resistant TB in 2016 were successfully treated while an estimated 19% died and 15% were lost to follow up [2]. These suboptimal treatment outcomes are a potential risk for the development and spread of further resistance to TB treatment [3].

Uganda currently implements a mixed model of care for MDR-TB characterized by initial hospitalization for two to eight weeks followed by ambulatory directly observed therapy at a public or private health facility near the patient’s home [4]. However, delivery of care through health facility-based directly observed therapy (HF-DOT) has been documented to significantly contribute to poor treatment outcomes particularly in resource limited settings [5]. Patients who receive care through HF-DOT experience various inconveniences (e.g., travel and waiting times) and incur significant direct (e.g., transport costs) and indirect costs (e.g., time lost from work) that hinder successful treatment completion [6, 7]. In the management of both drug susceptible and drug resistant TB, community-based treatment support models have been associated with improved treatment outcomes and increased cost effectiveness compared to health facility-based models [8–11].

Since March 2018, a shorter treatment regimen has been the standard of care for patients with MDR-TB without extrapulmonary TB or resistance to fluoroquinolones or injectable drugs. This regimen consists of six drugs; kanamycin (Km), moxifloxacin (Mfx), Ethionamide (Eto), clofazimine (Cfz), pyrazinamide (Z), high dose Isoniazid (H) and ethambutol (E) given in two phases; an intensive four-to-six-month period and a five-month continuation phase [4]. This treatment regimen is better tolerated, and in clinical trials resulted in better treatment outcomes than the two-year treatment regimen [12]. However, this regimen also has lower tolerance for lapses in adherence [4, 12, 13]. The provision of effective adherence support for patients receiving the shorter MDR-TB regimen is therefore a priority intervention for the National TB and Leprosy Program (NTLP). The provision of community-based adherence support has the potential to decrease patient costs [9, 11] and subsequently improve patient retention and lead to better treatment outcomes [3]. Further, the use of community health workers (CHWs) to offer treatment adherence support, particularly in the continuation phase of treatment, is recommended in the Uganda national guidelines for programmatic management of drug resistant Tuberculosis [4] but has not yet been implemented [14]. In order to design a patient centered community-based model for the management of multi-drug resistant TB, we set out to assess patient preferences for different attributes of community-based care.

Methods
Study setting
The study was carried out at five tertiary referral hospitals purposively selected because they provide care to about 80% of patients started on treatment for multi drug resistant TB in Uganda every year. At the time of the study, 302 MDR-TB patients were enrolled into care across study sites.

Study design
We used a parallel convergent mixed methods study design to collect both quantitative and qualitative data on patient preferences for different attributes of community-based care.

Sample size
In our discrete choice experiment, the number of tasks (t) was 8, the number of alternatives per task - not including the null alternative (a) was 2, and the number of levels for each attribute (c) was 3. Using the Orme and Johnson sample size calculation formula for discrete choice experiment [15]: \( N > \frac{500c}{(t \times a)} \) [16] and adding 10% for non-response, our estimated sample size was 104 respondents.
Selection of respondents

Between December 2018 and August 2019, 490 patients were started on treatment for MDR-TB in Uganda. Of these 302 patients were on the shorter, all oral treatment regimen and were therefore eligible for the study. We included patients 18 years or older who had completed the intensive phase of treatment and excluded 20 patients who had missing contact information. We used sampling proportionate to size to determine the number of patients to be selected from each hospital, and simple random sampling to select the patients to be interviewed at each hospital.

Data collection

We collected quantitative data on patient preferences using a discrete choice experiment (DCE) [17]. The DCE reveals how individuals’ value selected attributes of a program or service and allows for estimation of the relative importance of different aspects of care, the trade-offs between these aspects, and the total satisfaction respondents derive from health care services [18]. We chose three attributes (DOT provider, location of service, and provision of additional support) each with two or three attribute levels (Table 1). Attributes used in this study were chosen from an initial exploratory study carried out six months prior.

Attributes and levels

To identify the model attributes, the research team reviewed available policy documents and guidelines on provision of DOT for TB as well as published literature on community based models of care delivery [4, 19, 20]. Using a semi structured questionnaire, a pilot study was carried out at an urban hospital among patients with drug resistant TB to elicit their views on the proposed attributes and attribute levels. Results from this pilot study informed the final selection of attributes for this study e.g., healthcare workers were dropped from choice of DOT provider due to perceived unavailability by the respondents.

Using a fractional factorial design, we chose eight choice sets. Recommendations in the literature [21, 22] have shown that more than eight choice tasks are a cognitive and time burden for participants. We included an opt-out response category so that respondents could choose “neither” choice set to reflect dissatisfaction with either potential CB-DOT model. The final design had 96% d-efficiency (Table 2). To cater for limited literacy levels among the respondents, visual representations of each choice set were developed and used during data collection (Additional file 1). Additional data on age, gender, marital status, date of treatment initiation, duration on MDR-TB treatment, and underlying co-morbidities was abstracted from health facility records. Data was collected by research assistants with experience collecting quantitative data who were trained on the study tools and supervised by the research team. Data was then entered into an electronic web-based management system called TB management information system (tbmis).

Qualitative data was collected through patient interviews carried out after each choice set was presented to all study participants to find out the reasons for choices made for each set of attributes. Face to face interviews were held in local dialects to ascertain reasons for choosing each choice set. The interviews were carried out within the hospital premises and lasted from 10 to 30 min. The interview scripts were transcribed and entered into NVivo software version 12 for analysis.

| Table 1 | DCE attributes and levels |
|---------|---------------------------|
| **Attribute** | **Level** | **Attribute definitions for this study** |
| DOT Provider | Expert client | An individual who was treated for MDR-TB and recovered with good treatment outcomes. This person serves as an example in their community and helps others overcome a similar condition. |
| | Family member | An adult older than 18 years living with the MDR-TB patient in the same household. |
| | Community health worker | A person with basic health related training, who lives not more than an hour’s walk away from the patient’s home. |
| Location | Home | A place where one lives permanently, especially as a member of a family. |
| | Work | A place of employment to earn a living. It may be formal, informal, self-employed, or having an employer. In this study, this also included school for students. |
| Support type | SMS reminders | An appointment text message sent to a mobile telephone one week prior to the patients follow up clinic visit. |
| | Call reminders | A telephone call made one week prior to the patients follow up clinic visit at the tertiary hospital for treatment monitoring. |
| | Travel vouchers | A travel ticket worth 135 issued to the patient by the tertiary hospital with a date on which to return to the tertiary hospital for treatment monitoring. |
Data analysis

Quantitative data

Quantitative analyses were conducted using STATA software version 15.1 (StataCorp, College Station, Texas, USA). We described participants’ characteristics using descriptive summaries; frequency and percentages for categorical variables, median and inter-quartile range for count data like age, and duration on MDR-TB treatment.

DCE analysis to determine the patients’ preferred MDR-TB CB-DOT model

We used a mixed logit (MIXL) model (with 1000 Halton simulation draws and normal distribution) to determine the preferred attributes for community-based care for MDR-TB treatment, because MIXL estimates both the participants’ degree of preference and degree of heterogeneity in preference across study participants [21, 22]. Conditional relative importance of the attributes was estimated using range method [21, 22].

Subgroup analyses were conducted to examine whether participants’ preferences differ by age [<35, ≥35 years], gender [female, male], HIV status [negative, positive], and duration on MDR-TB treatment [<6, ≥6 months]. The significance level for all the analyses was determined at 5%.

To determine the preferred model of care, we calculated utility scores by substituting coefficients (preference weights) into the model equation (with different combination of attributes levels). The attributes combination with highest total utility score was considered as the preferred model.

Qualitative data

A deductive approach with descriptive thematic coding was used to analyse data using NVivo Version 12. The coding framework was developed using open coding by an experienced behavioural scientist (AT) after reading 5% of all transcripts. It was later reviewed by two members of the research team (RMM and DC). Subsequent analyses of transcripts were carried out by two members of the research team (RMM and DC) who then compared and discussed their findings. Discrepancies were resolved by mutual agreement. To ensure trustworthiness, transcripts were coded independently, compared, discussed [18]. Interview transcripts were

Table 2  DCE choice sets each with an opt out option

| Choice Set | Choice set alternatives | Attributes |
|------------|-------------------------|------------|
|            | Location of care | DOT provider | Support type |
| 1          | I work | CHW | Travel vouchers |
|            | II Home  | Expert Client | Call reminders |
|            | III Neither | | |
| 2          | I Home  | Family member | SMS reminders |
|            | II work | Expert Client | Travel vouchers |
|            | III Neither | | |
| 3          | I Home  | Family member | SMS reminders |
|            | II work | CHW | Call reminders |
|            | III Neither | | |
| 4          | I Home  | Expert Client | SMS reminders |
|            | II Home  | Family member | Call reminders |
|            | III Neither | | |
| 5          | I Home  | Family member | Travel vouchers |
|            | II Home  | CHW | SMS reminders |
|            | III Neither | | |
| 6          | I Work  | CHW | SMS reminders |
|            | II Home  | Expert Client | Travel vouchers |
|            | III Neither | | |
| 7          | I Work  | Expert Client | SMS reminders |
|            | II Home  | CHW | Call reminders |
|            | III Neither | | |
| 8          | I Work  | Expert Client | Call reminders |
|            | II Home  | CHW | Travel vouchers |
|            | III Neither | |
reviewed for content related to the research question. Codes were compared and similar codes aggregated, and consensus sought for validation coding. There was flexibility to accommodate emergent new themes as coding evolved. Data within and across themes were synthesized to generate an understanding of why certain attribute choices were preferred.

**Results**

**Socio-demographics**

From December 2019 to January 2020, 103 participants were interviewed. The majority, 58.3% were male, HIV negative (61.2%), and earned less than 1$/day (65.1%). The median age was 37 years (inter-quartile range [IQR] 30 to 47 year) (Table 3).

### Table 3: Baseline Characteristics of Study Participants

| Characteristics                        | Number (%) | N = 103 |
|----------------------------------------|------------|---------|
| **Gender**                             |            |         |
| Female                                 | 43 (41.7)  |         |
| Male                                   | 60 (58.3)  |         |
| **Age in years, median (IQR)**         | 37 (30–47) |         |
| **Age categories**                     |            |         |
| 20–34                                  | 42 (40.8)  |         |
| 35–80                                  | 61 (59.2)  |         |
| **Marital status**                     |            |         |
| Single/Single/Divorced/Separated       | 48 (46.6)  |         |
| Married                                | 55 (53.4)  |         |
| **Occupation**                         |            |         |
| Farmer                                 | 37 (35.9)  |         |
| Business                               | 24 (23.3)  |         |
| Employed                               | 33 (32.1)  |         |
| Unemployed                             | 9 (8.7)    |         |
| **Daily income ($)**                   |            |         |
| <1$                                    | 67 (65.1)  |         |
| ≥1$                                    | 36 (34.9)  |         |
| **Education**                          |            |         |
| None                                   | 11 (10.8)  |         |
| Primary                                | 58 (56.9)  |         |
| Secondary                              | 24 (23.5)  |         |
| Tertiary                               | 9 (8.8)    |         |
| **HIV status**                         |            |         |
| Negative                               | 63 (61.2)  |         |
| Positive                               | 40 (38.8)  |         |
| **Duration on MDR-TB treatment (months)** |       |         |
| Median (IQR)                           | 10 (5–16)  |         |
| Categories                             |            |         |
| < 6 months                             | 31 (30.4)  |         |
| ≥ 6 months                             | 71 (69.6)  |         |

* Missing values; Educational level (1), Duration on MDR-TB treatment (1)

**Discrete choice model analysis**

**Preference for specific attributes of community-based care**

Results for the mixed logit model (MIXL model) are presented in Table 4. Significant differences were observed between levels of each attribute, implying that all three attributes considered were important predictors of choice. The relative importance of each attribute was as follows; type of additional support (relative importance 36.2%), location of treatment delivery (33.5%), and type of DOT provider (30.3%). Participants significantly valued: (1) treatment delivered by CHWs or expert clients over that delivered by a family member; (2) treatment delivered at home over that delivered at the workplace; and (3) monthly travel vouchers as the form of additional support over phone call or SMS reminders.

The standard deviation estimates, indicating the preference variation among participants per attribute and level, were all significantly different from “0” (*P* values> 0.01) except for the phone call reminders (*P* value 0.74). The highest variation was on preference of treatment delivered by community health worker as DOT provider.

**Sub-group analysis**

Subgroup analyses showed significant difference for at least one attribute across HIV status, age groups and duration on MDR-TB treatment. There was no significant difference for preference of attributes across gender. Results for the three significant subgroup analyses are presented in Tables 5, 6 and 7.

The attribute valued highest by HIV negative MDR-TB patients valued was the additional treatment support (relevant importance of 38.4%), while that valued highest by HIV positive MDR-TB patients was the treatment location (43%). The subgroup analysis by age groups and duration on MDR-TB treatment, indicated that young patients (below 35 years) and those who had been on MDR-TB treatment for < 6 months placed the highest value on the treatment location whereas older persons and those who had been on treatment for ≥6 months placed the highest valued on the DOT provider.

**Preferred hypothetical models (combination of attributes) of community-based care**

Substituting the preference weights (coefficients) into the MIXL model to calculate total utility scores for a combination of attributes, the preferred community-based care model (i.e., set of attributes profile with highest total utility score) was a CHW giving treatment at the patient’s home and the patient receiving monthly travel vouchers for additional support. The models of care with the highest preference weights
Table 4  Results of random parameter logit model (mixed logit model) for the MDR-TB CB-DOT model attributes

| Attributes and levels<sup>a</sup> | Coefficients | 95%CI | P-value | SD | 95%CI | P-value<sup>†</sup> | Relative importance |
|----------------------------------|--------------|-------|---------|----|-------|----------------|-------------------|
| Constant                         | 0.52         | 0.30–0.74 | <0.01 | -  | -     | -              | -                |
| **DOT provider**                 |              |        |         |    |       |                | 30.3%             |
| Family (reference)               |              |        |         |    |       |                |                  |
| Community health work            | 1.13         | 0.68–1.59 | <0.01 | 1.85 | 1.33–2.37 | <0.01 |                  |
| Expert client                    | 0.89         | 0.46–1.32 | <0.01 | 1.77 | 1.24–2.30 | <0.01 |                  |
| **Location**                     |              |        |         |    |       |                | 33.5%             |
| Workplace (reference)            |              |        |         |    |       |                |                  |
| Home                             | 1.25         | 0.91–1.59 | <0.01 | 1.19 | 0.80–1.57 | <0.01 |                  |
| **Support**                      |              |        |         |    |       |                | 36.2%             |
| SMS (reference)                  |              |        |         |    |       |                |                  |
| Phone call reminders             | 0.70         | 0.41–0.99 | <0.01 | 0.19 | 0.95–1.33 | 0.74  |                  |
| Travel vouchers                  | 1.35         | 1.04–1.65 | <0.01 | 0.55 | 0.04–1.05 | 0.033 |                  |

<sup>a</sup> Dummy coded attributes (coefficient of the reference category is constrained to be 0)

CI: Confidence interval, SD: standard deviation for preference heterogeneity (random component of the model coefficients)

<sup>†</sup> P value testing the hypothesis that standard deviation (heterogeneity across individuals’ preferences) equals 0

Number of observations = 2472

Table 5  Results of random parameter logit model subgroup analysis for HIV status of respondent

| Attributes and levels<sup>a</sup> | HIV Negative | HIV Positive | P value<sup>†</sup> |
|-----------------------------------|--------------|--------------|---------------------|
|                                   | Coefficient | SD           | Relative importance| Coefficient | SD           | Relative importance|
| DOT provider                      |              |              |                     |              |              |                  |
| Family (reference)                |              |              |                     |              |              |                  |
| Community health work             | 1.22         | 1.78         | 0.95                | 1.09         | 2.07         | 0.356             |
| Expert client                     | 0.89         | 1.50         | 0.84                | 1.26         | 2.37         | 0.741             |
| Location                          |              |              |                     |              |              |                  |
| Workplace (reference)             |              |              |                     |              |              |                  |
| Home                              | 0.98         | 1.11         | 1.69                | 1.26         | 1.26         | 0.042             |
| Support                           |              |              |                     |              |              |                  |
| SMS (reference)                   |              |              |                     |              |              |                  |
| Phone call reminders              | 0.76         | 0.56         | 0.56                | 1.01         | 0.56         | 0.668             |
| Travel vouchers                   | 1.37         | 0.47         | 1.29                | 1.01         | 0.53         | 0.582             |

<sup>a</sup> Dummy coded attributes (coefficient of the reference category is constrained to be 0)

CI: Confidence interval, SD: standard deviation for preference heterogeneity (random component of the model coefficients)

Number of observations = 1512 (HIV negative), 960 (HIV positive)

<sup>†</sup> P value for indicating statistical difference in preference weights of attribute levels by HIV status

contained travel vouchers or treatment delivered at home (Table 8).

**Qualitative results**

The reasons for choice are presented around the attributes of DOT provider, location of care and type of support. Several key themes emerged from the data regarding the preferred attributes of community-based model of care and quotes documented to provide the patients perspective.

**DOT provider**

Theme: DOT provider type training and experience  Respondents reported that a CHW or expert client was preferred because they were trained and knowledgeable. In addition, they had the ability to offer adherence and psychosocial support including guidance on how to take their medications because of their professional or personal experience. Further, patients felt that expert
clients could be more empathetic because they have been through similar experiences. They therefore trusted them to maintain confidentiality in the process of offering care.

“A community health worker encourages you to take medicine than any other person. Also provides counselling to the patient and explains the benefit of taking medicines on time.” [20yr., Female, Single]

“I prefer an expert client to support me since he has been through the same situation. Expert client has the best experience ever [I] will be able to share with him.” [33yr., Male, Married]

“I prefer a CHW because they are knowledgeable, and I can trust them with my life.” [54yr., Male, Married]
Family members were least preferred and viewed as unable to offer the support needed.

“... family members, they sympathize so much and may discourage you from sticking to your treatment schedules as required and also they lack experience with this type of TB disease.” [22yr., Female, Single]

“... family members, they sympathize so much and may discourage you from sticking to your treatment schedules as required and also they lack experience with this type of TB disease.” [22yr., Female, Divorced/separated]

“... if visited at work, I could easily suffer from the gossip by workmates when they eventually learn about my condition, this could easily make me lose clients.” [55yr., Female, Divorced/separated]

**Location of care**

**Theme: convenience and confidentiality** Patients preferred to receive care from home citing privacy and a lower risk of TB-related stigma. They also felt that receiving care at home saves them time and money and presents an opportunity for health education for their family.

“The treatment at home also is a bonus, because the community cannot discriminate if confidentiality is kept by the expert client.” [29yr., Female, Divorced/separated]

“Treatment at home and monthly travel vouchers for monthly appointments is my preferred choice because there is time management while taking drugs since no out movement.” [66yr., Male, Married]

“It becomes less costly when I get treatment at home.” [31yr., Male, Married]

The workplace was not preferred by the majority of the respondents. It was associated with stigma and fear for loss of employment or clients.

“... family members, they sympathize so much and may discourage you from sticking to your treatment schedules as required and also they lack experience with this type of TB disease.” [22yr., Female, Single]

“... if visited at work, I could easily suffer from the gossip by workmates when they eventually learn about my condition, this could easily make me lose clients.” [55yr., Female, Divorced/separated]

**Support type**

**Theme: travel vouchers address patient needs** Participants felt that monthly travel vouchers were the best way to promote appointment keeping as they provided relief from worrying about transport costs and money left over transport fares could be used to meet other needs like food, other household items, payment of debts, savings and farming amongst others.

“Monthly travel vouchers are the best for me because I will be knowing that transport is readily available and even the ticket will be reminding me of the clinic appointment date.” [40yr., Male, Married]

“...because the money given for the travel voucher, the balance from it I can use it to buy other things and also do farming with it.” [52yr., Male, Married]

Sub-theme: treatment support reminders Some of the respondents did not prefer other types of patient support,
e.g., SMS or phone calls, due to various limitations surrounding their use which included:

“The message (SMS) reminders would work for me since am partially deaf and cannot easily hear through a phone call....” [43yr., Female, Divorced/separated/]
“....SMS reminders are not good for me because I don’t know how to read but may be if they call me and give transport to the clinic.” [40yr., Male, Married]

Discussion
We carried out a parallel convergent mixed methods study to determine patient preferences for different attributes of community-based care. We found that people with MDR-TB preferred care to be provided at home by a CHW or an expert client who is a member of the community and as additional support, to receive travel vouchers to enable attendance at monthly clinic follow-up visits. CHWs and expert clients were viewed as knowledgeable, experienced, empathetic, and skilled to properly counsel and guide patients on how to manage side effects. They were also seen as able to maintain confidentiality in the process of offering care. Family members were viewed as lacking adequate MDR-TB related knowledge and patients were skeptical of their ability to offer the support required.

Preference for and patient satisfaction with lay providers has also been observed elsewhere, such as in rural Swaziland where DOT and administration of injectable forms of MDR-TB medication was delegated to trained community treatment supporters [23]. In that study, preference for lay providers was driven by their ability to offer adherence counselling, confidentiality, and perceived lower treatment costs, reasons similar to those given by patients in our study.

The majority of respondents preferred home care noting it provides privacy, safety, comfort, and an opportunity for health education including infection prevention and control at the family level. Further, patients viewed home-based care as being less costly as it saves on time spent accessing care and daily transportation costs to follow-up health facilities. The workplace was perceived as a possible source of stigma that could lead to loss of clientele for small business owners or loss of employment. Similar to our study, findings from rural northern Uganda [24] showed that home-based care was acceptable to both patients and health providers noting that it is safe, conducive to recovery and time saving. This study further showed that home-based care enabled psychosocial support. In our study, however, psychosocial support was mentioned as a reason for preference for a certain provider type rather than place of care.

In Bangladesh, a decentralized, community-based treatment program for patients with drug-resistant tuberculosis used home-based care DOT to address various needs of MDR-TB patients. It was a patient’s preferred approach evidenced by their retention in care resulting into improvement in other treatment outcomes [25]. Similarly, a quasi-experimental study done in India showed that home-based care was associated with low stigma [26] similar to our study findings. In rural South Africa, MDR-TB patients preferred to receive MDR-TB and HIV care at home, and this was associated with reduced levels of rejection creating strong emotional bonds between patients, families and communities that is critical to health [27]. The home is seen as a place conducive for recovery and offers both psychological and emotional support needed to enable healing [28]. In the sub-group analyses, more MDR-TB patients who were HIV co-infected preferred to be treated at home than those who were HIV negative. This may be related to the fact that in 2017, Uganda rolled out differentiated service delivery models for persons infected with HIV that included community-based drug delivery options [20]. It is possible that clients’ positive experience with these care delivery models positively influenced their choice for home-based care [29].

Despite documented evidence that digital mobile technologies are useful in supporting TB care [30], majority of participants preferred monthly travel vouchers over mobile-based support, such as SMS and phone call reminders. In our study, varying degrees of literacy and hearing loss due to drug toxicity probably decreased the preference for mobile technologies. In addition, the utility of the travel voucher in meeting other household needs besides travel to the monthly hospital appointment served as a main driver for this choice. The majority of our respondents earned only about a dollar a day and were receiving a transport voucher worth about 50 dollars a month from the NTLP under its ongoing “enabler program”. The travel voucher therefore shielded them against incurring catastrophic costs during their treatment. In Uganda, a recent study done to examine costs incurred during TB treatment showed that that more than half of households affected by TB experienced catastrophic costs, defined as spending more than 20% of their annual income on TB and these costs were 30 times higher among MDR-TB patients compared to drug sensitive tuberculosis (DS-TB) patients [31]. The major drivers of cost according to the Uganda TB cost survey were
non-medical and included transportation, food, and nutritional supplements. Many respondents in our study reported that they could use money left over from the travel voucher to buy food. It is important to consider the unique needs of the sub-groups and the drivers of their behaviors so as to tailor interventions to address their specific needs. Further, due to the current COVID-19 pandemic, innovations that reduce the need for health facility visits while still providing additional support to meet client needs will become increasingly relevant [32].

The study had several strengths. We had regional representation across the country, involved health facilities that treat more than 80% of the MDR-TB cases. The results presented here are representative of patients receiving care for MDR TB across the country. In addition, we used patients who had been on treatment for MDR-TB. Their preferences were therefore grounded in their lived experiences with MDR-TB care. In addition, our study used pictorial questionnaires to aid understanding of choice sets and avoid strategic bias which could result in misrepresentation of preferences. However, our study had some limitations; we used routinely collected data which is prone to missing data. However, efforts were made to minimize this by training research assistants on quality data collection, triangulation of data sources and respective standard operating procedures prior to data collection. Finally we did not include children and other risk populations, like pregnant women so their preferences are not represented in our findings. Future studies could include children and other vulnerable populations so that their views are taken into consideration.

Conclusions and recommendations
Our respondents preferred to take their medicines at home supported by a member of their community but revealed a critical need for additional support to help mitigate the costs of accessing care. These patient preferences should be incorporated into future MDR-TB treatment approaches designed by the National TB Program. The feasibility and effectiveness of these models of care should be further evaluated. Studies to determine the feasibility and effectiveness of our preferred patient care model are underway.

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Authors’ contributions
RM: Study conceptualization, protocol development, supervision of data collection process, qualitative data analysis, preparation of initial draft, manuscript revisions. JM: Protocol review, quantitative data analysis, manuscript revisions. SZM: Study conceptualization, protocol review, supervision of data collection process, manuscript revisions. EK: protocol review, supervision of data collection process, MDR-TB technical input, manuscript revisions. HN: Supervision of data collection process, data management, manuscript revisions. PA: Supervision of data collection process, data management. DC: Protocol review, qualitative data analysis, manuscript revisions, overall study supervision. DBFL: Protocol review, manuscript revisions, overall study supervision. HB: Protocol review, qualitative data analysis, manuscript revisions. ST: Study conceptualization, protocol review, overall study supervision. AN: Study conceptualization, protocol review, overall study supervision, manuscript revisions. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study available from the corresponding author on request.

Declarations
Ethics approval and consent to participate
This research was performed in accordance with the Declaration of Helsinki guidelines. It was approved by the Joint Clinical Research Centre (JC1519) Institutional Review Board (IRB), and by the Uganda National Council of Science and Technology (HS2684) prior to study conduct. Administrative permission to collect this data were provided by the National TB and Leprosy Program. Prior to interview commencement, written informed consent was voluntarily obtained from all participants. Confidentiality of patients was ensured by using study identification numbers and data storage protection procedures.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
1The Infectious Diseases Institute, College of Health Sciences, Makerere University, P.O.Box 22418, Kampala, Uganda. 2USAID-Defeat TB Project, University Research Co. LLC, Plot 40 Ntinda II Road, P.O. BOX 28745, Kampala, Uganda. 3University Research Co. LLC, Chevy Chase, 5404 Wisconsin Avenue, Suite 800, Maryland 20815, USA. 4Ministry of Health-National TB and Leprosy Division, Kampala, Uganda.

Additional file 1. Pictorial to support DCE choices.
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