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Research paper

Exploring information provision to promote stem cell donation: Evidence from a field experiment of the Japan Marrow Donor Program

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ABSTRACT

Registered potential donors in stem cell transplantation may refuse to donate when matched with patients, causing supply shortages. To reduce such donor dropout, we developed behavioral interventions comprising messages added into the letters sent when donors are matched with patients in Japan, and conducted a field experiment to evaluate the effect of our intervention. The results demonstrate that the inclusion of our messages can reduce donor dropout and increase donor availability for transplantation. Specifically, the message emphasizing the limited number of compatible donors per patient increased the probability of donors completing the confirmatory typing stage by 7.3%. Since physicians can choose the best donor for proceeding to donation from those who complete confirmatory typing, this message increases donor availability for transplantation.

1. Introduction

Allogeneic hematopoietic stem cell transplantation (HSCT), a treatment with low relapse rates for leukemia and other blood cancers, faces supply shortages in many countries. Existing evidence — especially from organ transplantation — has focused on increasing the number of registered donors (e.g., Kessler and Roth, 2012). In allogeneic HSCT, however, there is an additional challenge: even registered donors may refuse to donate once they are matched with a patient (e.g., Switzer et al., 2018; Haylock et al., 2024). Mitigating such donor dropout is therefore crucial to stem cell supply. This study examines how behavioral interventions delivered upon matching can prevent donor dropout and alleviate supply shortages.

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HSCT transplants healthy hematopoietic stem cells from a donor into a patient after killing the tumor cells by anticancer drugs or radiation. Thus, the HSCT requires compatibility of white blood cell types (HLA) between the donor and the patient.[1] When patients cannot find a compatible donor among their relatives, who are more likely to be matched, they can search for unrelated donors through donor registries such as the National Marrow Donor Program (NMDP) in the United States, the Japan Marrow Donor Program (JMDP), and DKMS Germany.[2]

However, donor registries worldwide face dropout among registered donors (Switzer et al., 2004; Lown et al., 2014; Hamed et al., 2023). Donor candidates matched with patients undergo confirmatory typing (CT) to assess their eligibility for transplantation. Because physicians select the most suitable donor from those who complete CT, dropout before CT reduces donor availability. Dropout before CT is substantial across registries. For example, 56% of transplant coordinations in the JMDP do not reach the CT stage for donor-related reasons (Hirakawa et al., 2018).[3] Such dropout prolongs the time to transplantation and worsens patient outcomes (Lown and Shaw, 2013).[4] Thus, interventions to reduce pre-CT dropout are needed while preserving individual autonomy.[5]

In collaboration with the JMDP, we developed two information interventions embedded in the HLA match letter, which informs donors that they are matched with a specific patient and requests their participation in the transplantation coordination. Upon responding positively to this letter, matched donors proceed to the CT stage. The first intervention message (*matching difficulty*) emphasizes the limited number of HLA-compatible donors per patient to reduce motivational crowding out among altruistic donors (Bergstrom et al., 2009; Kurosawa et al., 2022). The second message (*early coordination*) highlights the importance of early coordination for patient outcomes to increase the perceived value of responding now and mitigate procrastination due to present bias (Laibson, 1997; O'Donoghue and Rabin, 2001).

To evaluate these interventions, we conducted a field experiment with the JMDP between September 2021 and February 2022. Our experimental participants comprised recipients of the 11,154 HLA match letters sent during the experimental period. To maintain randomness to the best of the JMDP office's abilities, we assigned treatment groups using weekly cluster randomization. After the experiment, we used the coordination data provided by the JMDP to estimate the effects of the interventions.

We found that our intervention increased the probability of donors reaching the CT stage. Specifically, the matching difficulty message increased the probability of reaching CT by 7.3%, whereas the early coordination message did not increase the probability of reaching CT. These findings are robust to several checks (e.g., adjusting multiple hypotheses testing across treatment groups) albeit without a prior pilot study or preregistration. Together, our field experiment suggests that the perceived scarcity of compatible donors reduces the motivational crowding out of altruistic donors.

The key distinction of our study compared with previous studies on information provision in donor engagement lies in the intervention objective and target population. Earlier studies mainly aimed to increase the number of registered donors and targeted the general population with lower baseline willingness to donate (Li, 2016; Sallis et al., 2018; Robitaille et al., 2021; Goette and Tripodi, 2020, 2024).[6] By contrast, we aimed to prevent dropout among registered donors rather than increase the total supply. Our target population therefore consists of registered donors, who are more likely to have altruistic preferences (Bergstrom et al., 2009; Ohtake et al., 2020).[7]

However, some studies share the same intervention goal as ours. Switzer et al. (2018) examined information provision interventions at the time of matching but their study was not a randomized controlled trial. Haylock et al. (2024) examined the effects of commitment before matching, and thus the timing of their intervention differs from ours. To the best of our knowledge, we are the first to document the effects of information provision at the time of matching among an altruistic population through a randomized controlled trial.

We also contribute to the literature on social norm messages, which tend to be effective when actions are publicly observable (Bursztyn and Jensen, 2017) and when the target population has low intrinsic motivation (Shang and Croson, 2009; Kessler, 2017). For HSCT, however, neither condition holds: donations are unobservable (to other donors and patients) and the target population is altruistic individuals already motivated to donate.[8] We instead show that a scarcity message (matching difficulty message) is effective in an altruistic population.

The remainder of this paper is organized as follows. Section 2 provides an overview of the coordination process of the JMDP and describes our field experiment. Section 3 presents the results of our experiment. Section 4 discusses the welfare implications. Finally, Section 5 concludes.

[1] When compatible unrelated donors are unavailable, several options exist: haploidentical stem cell transplantation and cord blood transplantation. The HLA requirements for these transplants are weaker than allogeneic HSCT. Notably, in Japan, allogeneic HSCT accounts for 20% of all transplants (Data source).

[2] While the probability of a complete match between two randomly selected individuals is less than 1%, the probability of a full match between siblings is 30%.

[3] As another example, in DKMS Germany, 23% of donors do not reach the CT stage (Haylock et al., 2024).

[4] In the JMDP, between 2004 and 2013, only 60% of the patients registered with the JMDP end up receiving transplantation. Moreover, 58% of patients who died (or had their transplantation interrupted because of poor health) passed away within 200 days (Hirakawa et al., 2018).

[5] Many registries have already undertaken activities to recruit new donors, so the marginal benefit of expanding the donor pool is limited. Indeed, in the JMDP, most patients do eventually find donor candidates (Takanashi, 2016).

[6] Heger et al. (2020) showed that establishing registries that collect potential donors beforehand is effective in increasing the supply of blood donation. For HSCT, such registries already exist.

[7] The effects of behavioral interventions such as message and information provision in health and medical policy contexts, including vaccination (for example, Dai et al., 2021; Milkman et al., 2021), breast cancer screening (Bertoni et al., 2020), and cord blood transplantation (Grieco et al., 2018), have also been examined. Unlike our study, these studies targeted the general population, including people with low motivation to take action.

[8] In particular, invoking social image can undermine the behavior of our target population. Allcott (2011) showed that the effect of social norm messages is limited to households that already had low electricity consumption. Gneezy et al. (2012) showed that in a Pay What You Want context, invoking social image crowds out the value of the self-image of being moral and altruistic and reduces willingness to pay for the good.

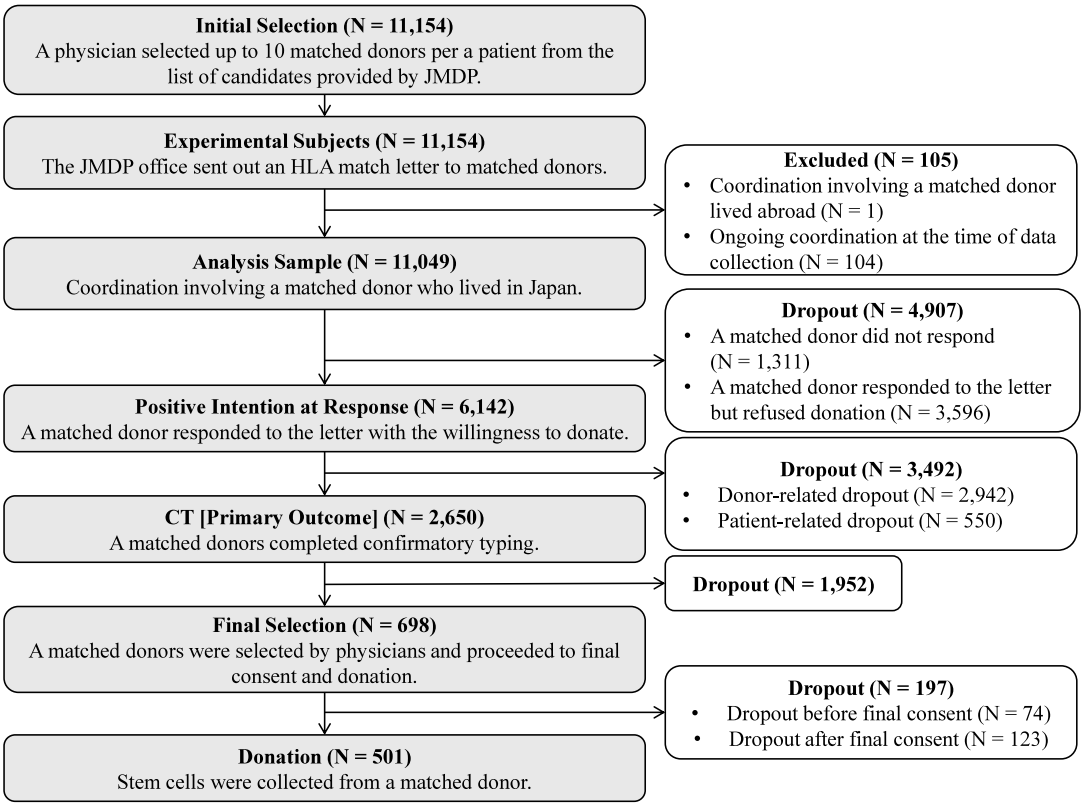

Fig. 1. Flowchart of the JMDP coordination process and sample selection. *Note*: Numbers based on our experimental data.

2. Field experiment

2.1. Background: Coordination process of the JMDP

We first describe who can register as donors with the JMDP and how the donor pool is composed. Individuals eligible to register as donors with the JMDP must be 18–54 years and in good health.[9] Individuals who can actually donate must be 20–55 years. As of December 2024, approximately 560,000 donors were registered with the JMDP. Of these, 240,000 (42%) were under 40 years and 280,000 (50%) were male.[10]

We next outline the coordination process leading to stem cell donation through the JMDP (Fig. 1). After a patient's physician registers the patient with the JMDP, the JMDP compiles a list of candidates based on the physician's criteria (primarily HLA compatibility). The physician selects up to 10 matched donors from this list. Subsequently, the JMDP office sends each matched donor an HLA match letter, recommending a response within 7 days.[11] Our experimental participants are all matched donors who received HLA match letters between September 2021 and February 2022. Upon responding, matched donors complete a medical questionnaire and indicate their willingness to donate.

A matched and willing donor undergoes CT within approximately one month to determine eligibility for transplantation. The transplantation coordinator asks matched donors and their families about their willingness to donate. Thereafter, the coordinating physician conducts medical examinations such as blood tests. CT can be skipped when a matched donor is eligible based on a previous CT result within a year.

The patient's physician selects the best donor from matched donors who have reached CT. Once the JMDP judges a matched donor to be eligible based on the CT results, the physician must classify the donor as the best donor, backup donor, or rejection. Only the best donor proceeds to final consent and donation, while up to four backup donors are designated and ranked by priority. If coordination with the best donor is interrupted, the highest-priority backup donor is promoted to the best donor.[12]

[9] Additionally, men must weigh at least 45 kg and women must weigh at least 40 kg. See https://www.jmdp.or.jp/reg/requirement/ (Japanese; Accessed October 24, 2025).

[10] Data source: https://www.bs.jrc.or.jp/bmdc/donorregistrant/m2_03_00_statistics.html (Japanese; Accessed October 24, 2025).

[11] Simultaneously, the JMDP office sends a short message to matched donors informing them that the JMDP has sent the HLA match letter.

[12] Even after selecting the best donor, if the JMDP determines that additional matched donors are eligible, the physician must classify them as backup donors or rejections. However, if the best donor has not yet provided final consent, the physician can change the best donor to a later-arriving matched donor.

Table 1
List of intervention messages.

Message	Content
Standard message	We inform you that your HLA type (white blood cell type) matches that of a patient in our registry, and you have been selected as one of our potential donors. We are contacting you to ask if you would like to proceed with further testing and interviews for donation. Please read the enclosed materials carefully, consider whether coordination is possible, and return the form within 7 days of receiving this information. [*Insert intervention messages here*] If we proceed with coordination after receiving your response, a coordinator will contact you by phone to discuss the details of your request.
Intervention message	
Matching difficulty message	The number of registered donors whose HLA type matches that of a single registered patient is one in hundreds to tens of thousands. While we may find multiple potential donors, we hope you understand that the number is limited.
Early coordination message	Approximately 60% of patients receive a transplant through the JMDP. The earlier a donor is found, the higher this rate can be.

Note: Translated by the authors.

The best donor must provide final consent after being informed of their selection by the coordinator and coordinating physician. Simultaneously, a representative of the donor's family must provide consent to the donation. After final consent is obtained, the donor cannot withdraw their decision to donate. They then undergo a surgical procedure to collect stem cells.[13] The time from CT to collection is three to four months. Importantly, throughout the coordination process, a matched donor cannot access any information about the matched patient.

2.2. Experimental design

Our intervention involved adding two messages into the HLA match letter.[14] Table 1 lists the content of the standard letter and the two intervention messages. The JMDP also encloses a handbook that describes the coordination process as well as the medical questionnaire and donor consent form.[15]

The matching difficulty message can reduce motivational crowding out among purely altruistic individuals by emphasizing the low number of matched donors per registered patient. Transplantation through the JMDP is a kind of public good because a transplant can be provided by other potential donors in the pool with the same HLA type (Bergstrom et al., 2009).[16] Then, the presence of substitutable donors can crowd out the motivation of purely altruistic individuals who care about transplant outcomes, consistent with qualitative evidence from interviews with previously matched donors (Kurosawa et al., 2022).[17] Thus, the matching difficulty message makes the donor's pivotal role more salient.[18]

The early coordination message emphasizes the value of not postponing the response to mitigate procrastination due to present bias. Donors with present bias may postpone their response to the HLA match letter because they incur immediate costs (e.g., consulting family members or colleagues) while they discount the future benefits of improved transplant outcomes (Laibson, 1997; O'Donoghue and Rabin, 2001). Highlighting the value of responding promptly may therefore reduce procrastination.[19]

Four experimental groups were established to estimate the effects of the two intervention messages. The first group received the standard HLA match letter with neither of the intervention messages, serving as the control group (StatusQuo group). The second and third groups received the standard HLA match letter including only the matching difficulty (MatchMessage group) and early coordination (CoordMessage group) messages, respectively. The last group received the standard HLA match letter with both intervention messages included to test the negative effect of information overload (BothMessage group).

[13] Collection methods (bone marrow (BM) or peripheral blood stem cell (PBSC) collection) are determined based on the preferences of the matched donor and coordinating physician.

[14] In designing our intervention messages, we were careful to avoid placing undue psychological pressure on potential donors. Specifically, we avoided using language that sounded like an appeal. Additionally, we only used information publicly available from the JMDP. Finally, the risks of transplantation were explained. The intervention message was approved by the institutional review boards of the Graduate School of Economics, Osaka University and the JMDP.

[15] The handbook can be found at https://www.jmdp.or.jp/pdf/en/DonorHandBook201708.pdf (Accessed December 9, 2024).

[16] Up to 10 candidates can be simultaneously matched with a single patient.

[17] Ohtake et al. (2020) estimated that 22% of registrants had purely altruistic preferences, while the remaining donors had selfish or warm-glow preferences. Donors with warm-glow preferences, who derive utility from the act of giving, may choose to donate regardless of the presence of substitutable donors (Andreoni, 1990).

[18] Two other potential mechanisms may operate. First, the message may reduce the decision-related uncertainty among matched donors (Exley, 2016). Second, the message may make the rarity of the opportunity to donate more salient, which may change donor behavior.

[19] Commitment is a representative solution to procrastination. For example, informing the registry in advance about donation periods is one form of commitment (Haylock et al., 2024). The timing of our intervention differs from commitment-based interventions.

Table 2
Assignment schedule.

week	September 2021	October 2021	November 2021	December 2021	January 2022	February 2022
1	MatchMessage (09/06 to 09/12)	CoordMessage (10/04 to 10/10)	CoordMessage (11/01 to 11/07)	BothMessage (11/29 to 12/05)	MatchMessage (01/03 to 01/09)	StatusQuo (01/31 to 02/06)
2	BothMessage (09/13 to 09/19)	MatchMessage (10/11 to 10/17)	StatusQuo (11/08 to 11/14)	StatusQuo (12/06 to 12/12)	CoordMessage (01/10 to 01/16)	MatchMessage (02/07 to 02/13)
3	StatusQuo (09/20 to 09/26)	BothMessage (10/18 to 10/24)	MatchMessage (11/15 to 11/21)	CoordMessage (12/13 to 12/19)	BothMessage (01/17 to 01/23)	CoordMessage (02/14 to 02/20)
4	CoordMessage (09/27 to 10/03)	StatusQuo (10/25 to 10/31)	BothMessage (11/22 to 11/28)	MatchMessage (12/20 to 12/26)	StatusQuo (01/24 to 01/30)	BothMessage (02/21 to 02/27)

Note: The experiment was not conducted from December 27, 2021 to January 3, 2022 because the JMDP was closed for the New Year's holiday.

We assigned the HLA match letters to the four experimental groups using weekly cluster randomization to maintain randomness to the best of the JMDP office's abilities (Table 2). The participants were the recipients of the 11,154 letters sent out to matched donors between September 6, 2021 and February 27, 2022.[20] Each week (starting from Monday) was assigned to one experimental group. The schedule was designed to be balanced across weeks and months.

Before conducting the experiment, we obtained approval from the institutional review boards of the Graduate School of Economics, Osaka University (approval number: R030305) and the JMDP (approval number: JMDP2021-04) for the experimental design and empirical strategy. We did not conduct pilot studies and did not register the experiment with a pre-analysis plan.

2.3. Data and empirical strategy

The coordination data provided by the JMDP included donor characteristics (sex, age, coordination experience, and residential prefecture) and information on the coordination process such as stages completed (response to the letter, CT, donor selection, final consent, and collection), days to respond to the HLA match letter, and willingness to donate.[21] If the coordination process was interrupted before donation, the reasons were recorded as patient-side reasons, donor non-health reasons, and donor health reasons. Unfortunately, the data contained no patient information on characteristics or prognosis.

As additional data, we used the list of medical institutions on the JMDP website.[22] We aggregated this list at the prefecture level and calculated the number of hospitals per 10 square kilometers using the land area data from the Geospatial Information Authority of Japan. This aggregated dataset was merged with the coordination data using the prefecture as the merge key. We considered this variable as the traveling cost of coordination and donation.

The sample included 11,049 completed or interrupted coordinations involving matched donors in Japan.[23] Of these coordinations, 4.5% resulted in donation and 63.4% involved matched donors coordinating for the first time. The mean age of matched donors was 37.9 years (median 39) and 62.4% of coordinations involved male donors. The sample included slightly more young and male donors than the overall donor pool.[24]

The primary outcome was whether matched donors underwent CT. Reaching the CT stage requires donors to respond to the HLA match letter, indicate their willingness to donate, and maintain their intentions. Additionally, late responses are associated with coordination interruptions before the CT stage (Fig. 2). Further, physicians can select the most appropriate donor for transplantation from among the matched donors who have undergone CT. Thus, showing up for CT represents both a costly prosocial behavior and an important practical indicator of coordination.

In the StatusQuo group, 22.25% reached CT. Breaking this down, 54.91% indicated willingness to donate, and 40.52% of willing donors reached CT (i.e., 59.48% of willing donors dropped out between response and CT). These figures highlight two obstacles to reaching CT: low willingness to donate at response and dropout between response and CT. Of these dropouts, 85.99% were for donor-related reasons: health conditions such as lower back pain (75.24%) and non-health reasons such as scheduling conflicts and the lack of family consent (10.75%).[25] Health reasons are less likely to be directly affected by our intervention, whereas non-health reasons are more plausibly influenced by donors' coordination and decision-making and thus may be more responsive to our intervention. To examine whether our messages mitigate these obstacles, we construct two secondary outcomes: "positive intention at response" and "donor-related dropout for non-health reasons".

[20] In a few cases, the same registrant matched with more than one patient and received letters multiple times.

[21] The unit of observation was a coordination.

[22] Data source: https://www.jmdp.or.jp/hospitals/view2/ (Accessed August 4, 2022). This list includes complete addresses, the availability of bone marrow collection, and the availability of PBSC collection.

[23] One coordination involved a matched donor who lived abroad. There were 104 coordinations ongoing at the time of data collection, and their proportion was balanced across the experimental groups (F-test, p-value = 0.383). We exclude these cases from the analysis.

[24] Altogether, 17.1% of coordinations involved matched donors living in Tokyo or Osaka, where hospital density is above the national average of 0.21 (1.86 and 1.36, respectively).

[25] Hirakawa et al. (2018) reports that, among donor-related dropouts, approximately 69% are due to donor health conditions, 16% to scheduling conflicts, and 10% to the lack of family consent. In our classification, the latter two are grouped as non-health reasons.

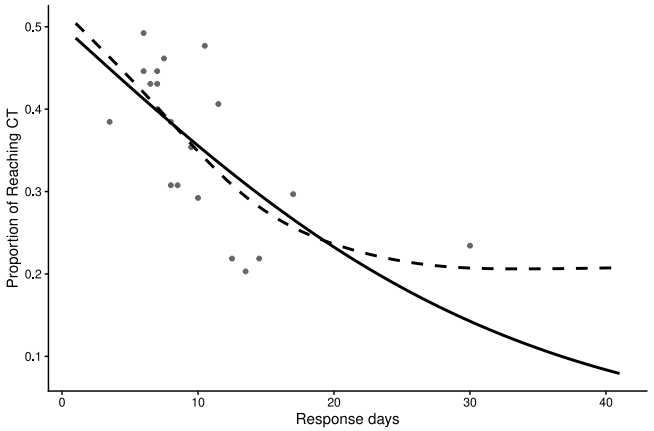

Fig. 2. Binned scatter plot of CT vs. Response speed among those who responded with positive intention.
Note: We used those who responded with positive intention to donate in the control group (StatusQuo group). The dashed line represents nonparametric fitting. The solid line represents a fitted line of the logistic regression.

Table 3
Summary of the field experiment.

	Experimental Groups				
	StatusQuo	MatchMessage	CoordMessage	BothMessage	F-test, *p*-value
A. Interventions					
Standard message	X	X	X	X	
Matching difficulty message		X		X	
Early coordination message			X	X	
B. Sample Size					
N	2535	3053	2726	2735	
C. Balance Test					
Male (= 1)	0.624	0.633	0.631	0.609	0.231
Age	38.376	38.121	37.448	37.978	0.004
Number of past coordinations	1.609	1.589	1.625	1.563	0.130
Number of listed hospitals	0.476	0.490	0.487	0.485	0.835
Number of hospitals listed with PBSC collection	0.162	0.167	0.166	0.164	0.838
Number of hospitals listed with BM collection	0.246	0.256	0.254	0.251	0.741
Number of holidays	4.544	5.828	4.466	4.770	0.000
Skipped CT (= 1)	0.039	0.047	0.046	0.050	0.233

Note: For the balance test, we regressed a covariate on treatment dummies and tested the null hypothesis that all coefficients are zero. We used standard errors clustered by the assigned week for the statistical inference. Abbreviations: PBSC, peripheral blood stem cell; BM, bone marrow.

Panels A and B in Table 3 present the intervention and sample size for each experimental group, respectively. Panel C presents a balance test of whether the randomization was successful. Although we find statistically significant differences in average age and in the number of holidays in the assignment week and following week across the groups, these differences are either negligible in terms of standardized mean difference (average age: the CoordMessage group is only approximately a year younger than the StatusQuo group; Table A1 in Supplementary Material A) or mechanically explained by the New Year's holiday falling in the following week for one MatchMessage cluster in December (Table 2).

Although most covariates were balanced across the experimental groups, a few were unbalanced.[26] In addition to a simple difference-in-means test, we therefore estimated the following linear regression model for HLA match letter i sent out in week w of month m:

$$Y_{iwm} = \alpha + \beta_1 \cdot \text{MatchMessage}_{wm} + \beta_2 \cdot \text{CoordMessage}_{wm} + \beta_3 \cdot \text{BothMessage}_{wm} + X'_{iwm}\gamma + u_{iwm}, \quad (1)$$

where X_{iwm} is a vector of observable characteristics, including donor age and the number of holidays. The parameters of interest are $(\beta_1, \beta_2, \beta_3)$.

[26] Age and the number of holidays did not affect CT, which is our primary outcome, in the StatusQuo group (Table A2 in Supplementary Material A). Therefore, the imbalance in some covariates is not a major concern.

Table 4
Effect of the intervention messages on reaching CT.

	CT		
	(1)	(2)	(3)
MatchMessage group	3.10**	2.56*	1.63**
	(1.42)	(1.24)	(0.70)
CoordMessage group	1.19	0.50	0.27
	(1.55)	(1.18)	(0.90)
BothMessage group	2.39	1.64	1.11
	(1.63)	(1.65)	(0.80)
Control average	22.25	22.25	22.25
Covariates		X	X
Month FE			X
Num.Obs.	11 049	11 049	11 049

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered by the assigned week are in parentheses. The unit of treatment effect is a percentage point. Covariates are sex, age, its squared term, the number of past coordinations, the number of public holidays in the assigned week and following week, the number of hospitals per 10 square kilometers, the number of hospitals with PBSC collection per 10 square kilometers, the number of hospitals with bone marrow collection per 10 square kilometers, and a dummy indicating that a candidate can skip CT. All the covariates except the sex dummy and dummy of skipped CT were demeaned. Column (1) reports raw results (without covariates and month fixed effects). Column (2) controls for covariates. Column (3) controls for covariates and month fixed effects.

There may be within-patient correlation because multiple donors can be matched with the same patient and physicians select one from among those who reach CT. Ideally, we would cluster standard errors at the patient level (or two-way by patient and the assigned week) but we do not have patient IDs. Instead, we cluster standard errors by the assigned week, the level of treatment assignment, which can also partially capture patient-level correlation when donors matched with the same patient receive letters in the same week.

3. Experimental results

3.1. Average treatment effects on reaching CT

We used a dummy variable coded one if a matched donor reached the CT stage.[27] As discussed in Section 2.3, the main barriers are low willingness to donate and donor-related dropout between the response and CT stages. We therefore expect that our intervention messages mitigate these barriers and increase the probability of reaching the CT stage.

Table 4 shows that the MatchMessage group increased the probability of coordinations reaching the CT stage by 1.63 percentage points, controlling for covariates and month fixed effects (column (3)). We obtain similar results under several alternative specifications: removing covariates and month fixed effects, adjusting for multiple hypotheses testing following List et al. (2019) (Figure A1 in Supplementary Material A), and using logistic regression (Table A3 in Supplementary Material A). We do not find statistically significant positive effects on reaching CT for the CoordMessage or BothMessage groups. Therefore, including the matching difficulty message in the HLA match letter is an effective intervention to accelerate transplant coordinations.

As the intervention was expected to increase CT completion by both increasing positive intention at response and reducing donor-related dropout with non-health reasons between the response and CT stages, we decomposed the message effects into these two components (Table 5). In the preferred specification (with covariates and month fixed effects), the MatchMessage and BothMessage groups may have reduced donor-related dropout for non-health reasons by 0.61 percentage points (statistically significant at the 10% and 5% levels, respectively; column (6)), although these results are not robust across model specifications. For the CoordMessage group, we do not find effects on either willingness to donate or donor-related dropout for non-health reasons.

We did not find a statistically significant effect of the BothMessage group on CT, although this group reduced donor-related dropout for non-health reasons to the same magnitude as the MatchMessage group. Our data cannot make a definitive conclusion on this paradox. Nevertheless, one hypothesis is the difference in point estimates of positive intention at response: 1.27 percentage points in the MatchMessage group versus 0.12 percentage points in the BothMessage group (column (3)). Since neither estimate is statistically significant, we cannot establish this hypothesis.[28]

[27] We also coded the CT dummy one if CT was skipped.

[28] When we exclude month fixed effects from the specification, the positive effect of the MatchMessage group on positive intention is statistically significant at the 10% level.

Table 5
Decomposition of the effect on reaching CT.

	Positive intention at response			Donor-related dropout for non-health reasons		
	(1)	(2)	(3)	(4)	(5)	(6)
MatchMessage group	2.31*	1.86*	1.27	−0.14	−0.73*	−0.61*
	(1.33)	(1.07)	(0.93)	(0.48)	(0.35)	(0.32)
CoordMessage group	−0.44	−0.05	−0.31	−0.10	−0.07	−0.05
	(1.43)	(1.22)	(1.18)	(0.53)	(0.50)	(0.44)
BothMessage group	0.59	0.24	0.12	−0.55	−0.68**	−0.61**
	(1.61)	(1.37)	(1.09)	(0.37)	(0.31)	(0.27)
Control average	54.91	54.91	54.91	3.51	3.51	3.51
Covariates		X	X		X	X
Month FE			X			X
Num.Obs.	11 049	11 049	11 049	11 049	11 049	11 049

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered by the assigned week are in parentheses. The unit of treatment effect is a percentage point. The outcome "Donor-related dropout for non-health reasons" is a dummy variable that takes a value of 1 if candidates responded with a willingness to donate but did not reach the CT stage for donor-side non-health reasons such as scheduling conflicts or the lack of family consent. Covariates are gender, age and its squared term, the number of past coordinations, the number of public holidays in the assigned week and the following week, the number of hospitals per 10 square kilometers, the number of hospitals with PBSC collection per 10 square kilometers, the number of hospitals with BM collection per 10 square kilometers, and a dummy indicating that the candidate skipped CT. All the covariates except the gender dummy and dummy of skipped CT were demeaned.

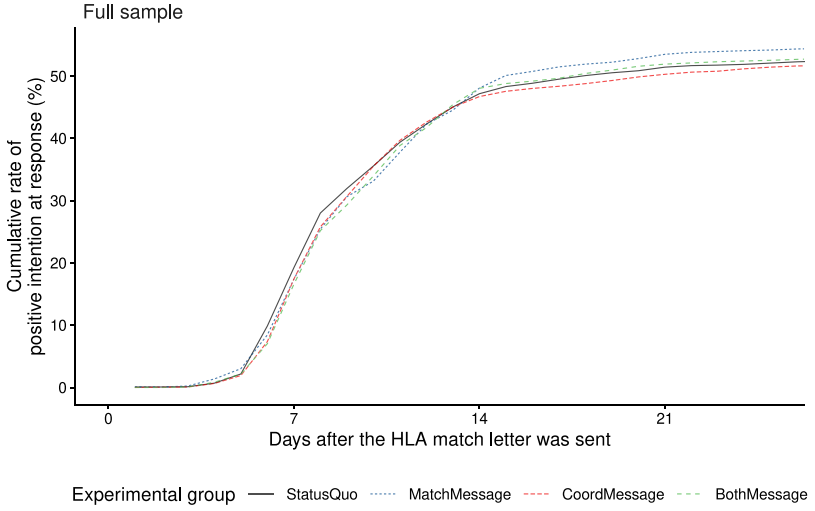

Fig. 3. Cumulative rate of positive intention at response by treatment.
Note: We excluded those who skipped CT. We only show the cumulative response rates up to 25 days after the HLA match letter was sent because there was no remarkable change in the response rate thereafter.

3.2. Effect on the response speed

Although we did not find that the early coordination message increased positive intention at response overall (Table 5), we expect that this message reduces procrastination (see Section 2.2). In this subsection, we examine whether our interventions reduce delayed responses and increase early responses with positive intention.

Fig. 3 plots the cumulative rate of willingness to donate over time. At least through the first two weeks after the letter was sent, none of the interventions increased willingness to donate. Moreover, the matching difficulty message increased the cumulative rate of willingness to donate relative to the StatusQuo group after the first two weeks. Taken together, while the interventions did not promote earlier responses, only the matching difficulty message increased willingness to donate later.

Delays in responses associated with the matching difficulty message are not procrastination by donors who already intended to donate. Rather, they reflect that some candidates who had declined early expressed willingness to donate later. The left panel of Figure A2 in Supplementary Material A shows that the rate of expressing willingness within 10 days in the MatchMessage group

Table 6
Effect on response speed with positive intention.

	0–9 days			10–17 days			18–85 days		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MatchMessage group	−0.73	1.47	0.09	3.00	0.57	1.38	0.04	−0.18	−0.20
	(3.12)	(2.78)	(1.14)	(2.21)	(2.11)	(1.21)	(0.51)	(0.45)	(0.49)
CoordMessage group	−0.70	−0.76	−0.78	−0.01	0.45	0.24	0.27	0.27	0.24
	(3.89)	(3.26)	(1.82)	(3.03)	(2.87)	(1.65)	(0.59)	(0.55)	(0.46)
BothMessage group	−1.76	−1.88	−2.53	2.46	2.22	2.62*	−0.10	−0.10	0.03
	(3.45)	(3.59)	(1.57)	(2.52)	(2.61)	(1.45)	(0.55)	(0.55)	(0.47)
Control average	34.60	34.60	34.60	16.88	16.88	16.88	3.43	3.43	3.43
Covariates		X	X		X	X		X	X
Month FE			X			X			X
Num.Obs.	11 049	11 049	11 049	11 049	11 049	11 049	11 049	11 049	11 049

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered by the assigned week are in parentheses. The unit of treatment effect is a percentage point. The outcome is a dummy variable that takes a value of 1 if the candidate responded with positive intention within a specified time window after the HLA match letter is sent. Covariates are gender, age and its squared term, the number of past coordinations, the number of public holidays in the assigned week and the following week, the number of hospitals per 10 square kilometers, the number of hospitals with PBSC collection per 10 square kilometers, and the number of hospitals with BM collection per 10 square kilometers. All the covariates were demeaned.

was similar to that of the StatusQuo group (or slightly lower), but the MatchMessage group's rate was higher on days 10–17.[29] The right panel shows that the MatchMessage group had a lower rate of declining donation within 7 days than the StatusQuo group.[30] We expect that this pattern reflects increased positive intention to donate through behavioral change among those who had declined early.

To test formally, Table 6 reports treatment effects on positive intention within non-overlapping time windows: 0–9 days, 10–17 days, and 18–85 days. We do not find statistically significant effects for the MatchMessage and CoordMessage groups in any of these time windows. For the BothMessage group, the estimated effect in the 10–17 day window is positive and statistically significant at the 10% level in our preferred specification (column (6)), but this result is not robust across alternative specifications (columns (4)–(5)). Thus, although the descriptive patterns above are consistent with later conversion to willingness to donate among early decliners in the MatchMessage group, we cannot establish this timing effect for the MatchMessage group.[31]

4. Policy and welfare implications of the intervention

To discuss the policy and welfare implications of the intervention, we examine the treatment effects on the post-CT stages: donor selection, final consent, and collection (donation). Because a physician selects the best donor from all who reach CT, welfare depends on both the number and the quality of donors in the pool. We argue that the intervention may have improved transplant quality despite the null quantity effects and that targeting clinically valuable donors could still improve welfare.

We first report the treatment effects on the post-CT outcomes. As a benchmark, when the JMDP sends HLA match letters to 10 donors and all reach CT, selection and donation rates can reach 10%.[32] In the StatusQuo group, the selection and donation rates are 6.19% and 4.50%, respectively; the gap reflects dropout due to patient deterioration or failure to obtain final consent. In terms of quantity, the effects of our intervention on the post-CT outcomes are neither statistically significant nor robust (Figure A5 and Table A4 in Supplementary Material A). The estimated effects on all three stages are smaller than on the CT stage: donor selection and donation in the MatchMessage group fell by 0.71 and 0.48 percentage points, respectively.[33]

This need not imply, however, that patient welfare did not improve. Because more donors reached CT in the MatchMessage group, physicians could choose from a larger pool—potentially raising transplant quality even without increasing quantity.

[29] Summing rates at each time point in Figure A2 (in chronological order) yields the cumulative distribution in Fig. 3. In the left panel of Figure A2, the MatchMessage group had higher rates of expressing willingness to donate on days 10–17, but this was offset by slightly lower rates in earlier intervals. Once the rates were summed over the first two weeks for each group, the MatchMessage group had similar cumulative rates to those in the StatusQuo group. From day 14 onward, cumulative rates were higher in the MatchMessage group.

[30] Compared with the StatusQuo group, the distributions of the CoordMessage and BothMessage groups also changed similarly, but the change was less pronounced than in the MatchMessage group (Figures A3 and A4 in Supplementary Material A).

[31] Even if some donors responded one to two weeks later, the adverse consequences for patients are likely to be limited. The median interval from patient registration to transplantation is 146 days (Hirakawa et al., 2018), making a 10–17-day delay in donor response relatively small in the context of the overall transplantation process. Moreover, downstream coordination steps — such as CT, final consent, and collection scheduling — introduce additional variability into the timeline, and the registry and hospitals may be able to adjust these steps to partly offset differences in initial response time of this magnitude. Consequently, increasing the share of donors who express willingness to donate and proceed to CT may be more important for patients than accelerating initial response speed.

[32] When no desirable donors are found through CT or when few matched donors complete this stage, a physician may be unable to find the best donor among matched donors. In this case, selection and donation rates fall below 10%. Conversely, when the JMDP sends HLA match letters to fewer than 10 matched donors, selection and donation rates exceed 10%.

[33] Logistic regression yielded similar results (Table A5 in Supplementary Material A).

This view is supported by the heterogeneous treatment effects by sex, age, and past coordination experience (Figure A6 in Supplementary Material A). The MatchMessage treatment may have encouraged young men with past coordination experience to reach CT (6 percentage points; $p = 0.098$) and increased their probability of being selected as the best donor (4 percentage points; $p < 0.01$). This result is desirable given evidence that young male donors improve patient prognosis (Loren et al., 2006; Arai et al., 2016; Kollman et al., 2016; Shinohara et al., 2017).[34] The MatchMessage treatment may thus improve transplant quality by selectively attracting the most clinically valuable donors.

Simultaneously, the MatchMessage treatment promoted older men matched for the first time (6 percentage points; $p = 0.0152$) and women with past coordination experience to reach CT (8 percentage points; $p = 0.0903$ for young women and $p = 0.0345$ for older women), but did not increase their probability of selection, suggesting welfare costs for these donors.[35] From the perspectives of welfare and cost-effectiveness, interventions targeting young men may therefore be more appropriate than a uniform message to all matched donors.

5. Conclusions

Our field experiment showed that the matching difficulty message increased the probability of reaching CT by 1.63 percentage points after adjusting for covariates and month fixed effects. Given the baseline CT completion rate of 22.25% in the StatusQuo group, this implies a 7.3%(= 1.63/22.25) increase. This result is robust to several other checks (adjusting for multiple hypotheses testing across treatment groups and using logistic regression) albeit without a prior pilot study or preregistration. Overall, the matching difficulty message expands the pool from which physicians can select the best donor.

To evaluate cost-effectiveness, we estimated that the message effect is equivalent to recruiting 40,880 registrants (see Supplementary Material B for details). Since 100,000 donors in their 50s will exit within the next five years because of the age limit for donation (55 years), the message effect can offset approximately 40.9% of the negative impact of this donor pool shrinkage.[36] Meanwhile, donor recruitment is costly. If the JMDP bears a similar cost to the NMDP (USD 150 per added registration), recruiting 40,880 registrants would cost approximately USD 6.132 million.[37] Thus, adding the matching difficulty message could be a more cost-effective measure than recruiting new donors to address the shrinking donor pool.

The effectiveness of the matching difficulty message was attenuated when we simultaneously presented the early coordination message, possibly due to information overload. This suggests that effective behavioral information should be conveyed simply. Moreover, given that the matching difficulty message may have encouraged young men to reach CT and increased their likelihood of selection, targeted interventions directed at this subgroup may be more cost-effective than a uniform intervention.

Finally, our intervention may apply to contexts beyond stem cell transplantation. The matching difficulty message emphasizes the scarcity of potential cooperators in public-goods settings. In our context, it may have corrected donors' overestimation of available substitutes and reduced motivational crowding-out. Alternatively, it may have made the rarity of cooperative opportunities more salient. Although our data cannot identify the dominant mechanism, communicating scarcity is likely to be effective in other cooperative settings such as rare-blood donation.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, we used Claude to improve the readability and language of the manuscript. After using these tools, we carefully reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Declaration of competing interest

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[34] Using those in the StatusQuo group who reached the CT stage, we found that young men were more likely to be selected as the best donor, consistent with medical findings (Table A6 in Supplementary Material A). We also found that donor selection and donation were unrelated to the speed of reaching the CT stage (those who responded to the HLA match letter quickly or could skip CT).

[35] The MatchMessage treatment changed the behavior of both those likely to be selected as donors and those unlikely to be selected, resulting in average treatment effects on donor selection and donation that were close to zero. This reflects that, among those who reached CT, the MatchMessage treatment increased coordinations interrupted for donor health reasons (mainly disqualification based on the CT results) or for patient-side reasons (Table A7 in Supplementary Material A).

[36] Data source: https://www.jmdp.or.jp/about/read/number/ (Accessed December 8, 2024).

[37] Data source: https://fundraise.nmdp.org/index.cfm?fuseaction=cms.page&id=1203&eventID=675 (Accessed March 29, 2025).

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jebo.2026.107666.

Data availability

Although the data used in this article is confidential, we have shared our code at GitHub repository (https://github.com/JMDP-behavioral-economics/RCT-Nudge).

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