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Increased Utilization of Virtual Visits and Electronic Approaches in Clinical Research During the COVID-19 Pandemic and Thereafter

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Abstract

Objectives: To assess the impact of the COVID-19 pandemic on clinical research and the use of electronic approaches to mitigate this impact.

Methods: We compared the utilization of electronic consenting, remote visits, and remote monitoring by study monitors in all research studies conducted at Mayo Clinic sites (Arizona, Florida, and Minnesota) before and during the COVID-19 pandemic (ie, between May 1st 2019 and December 31st 2020). Participants are consented through a participant tracking system linked to the electronic health record.

Results: Between May 2019 and December 2020, there were 130,800 new consents across every modality (electronic and paper) to participate in a non-trial (107,176 [82%]) or a clinical trial (23,624 [18%]). New consents declined from 5,741 in February 2020 to 913 in April 2020 but increased to 11,864 in November 2020. The mean (SD) proportion of electronic consent increased from 22 (2)% before to 45 (20)% during the pandemic (P=.001). Mean (SD) remote electronic consenting increased from 0.3 (0.5)% to 29 (21)% (P<.001). The mean (SD) number of patients with virtual visits increased from 3.5 (2.4) to 172 (135) (P=.003) per month between pre-COVID (July 2019-February 2020) and post-COVID (March-December 2020) periods. Virtual visits used telemedicine (68%) or video (32%). Requests for remote monitor access to complete visits increased from 44 (17)/month between May 2019 and February 2020 to 111 (74)/month between March and December 2020 (P=.10).

Conclusions: After a sharp early decline, the enrollment of new participants and ongoing study visits recovered during the COVID-19 pandemic. This recovery was accompanied by the increased utilization of electronic tools.
Abbreviations

EHR, electronic health record
HIPAA, Health Insurance Portability and Accountability Act
IRB, Mayo Clinic Institutional Review Board
PTrax, Participant Tracking System
Background

Clinical trials are necessary for evaluating and validating the efficacy and safety profile of drugs, devices, and other therapies. Most clinical trial-related activities entail in-person visits to evaluate participants and collect data. The need for in-person visits and other factors increase participant burden, discourage participation, and increase the duration and expense of conducting clinical trials.\textsuperscript{1} Indeed, only a minority of patients (eg, only about 8\% of cancer patients nationwide) participate in a clinical trial.\textsuperscript{2}

During the COVID-19 pandemic, the need for social distancing, stay-at-home orders, the influx of COVID-19 infected patients, and the temporary cessation of clinical trials markedly hindered the conduct of clinical trials\textsuperscript{3}; initiation of new trials, enrollment of new patients into trials, and assessments in existing patients all declined.\textsuperscript{3-5} Initially, all but potentially life-saving treatment trials came to a standstill. On April 21 2021, there were 1773 suspended clinical trials in ClinicalTrials.gov.\textsuperscript{6} Many trials identified the COVID-19 pandemic as the primary reason for suspension. Based on early trends (ie, in April 2020), it was estimated that clinical trial accrual for National Cancer Institute-funded studies alone will decrease by approximately 20\% to 25\% (or approximately 3,500 patients) in 2020.\textsuperscript{7} Gradually activities resumed, prompted by the need to meet the ethical obligations to patients and the research process, while adapting to stay-at-home orders. Aligned with US Food and Drug Administration’s regulations that allowed for, “exceptions where necessary to eliminate apparent immediate hazards to the human subjects” (21 CFR 56.108(a)(4), where feasible, face-to-face visits were replaced with virtual visits.\textsuperscript{8} In addition, the US Food and Drug Administration and other agencies provided guidance on measures to mitigate the risk while ensuring compliance with Good Clinical Practice.\textsuperscript{8-10} This guidance, which addressed several issues (eg, informed consent, scheduling laboratory tests, and dispensing of study medications), provided the framework for safely continuing
research. Institutions and study sponsors implemented several modifications to overcome these challenges.

At Mayo Clinic, prior to the pandemic, most research studies documented informed consent in person and via hard copy. Likewise, a majority of study visits were conducted in person. The aims of this study were to compare the utilization of electronic consent, virtual (telemedicine and video) visits, and virtual monitoring of trials by study monitors before and during the COVID-19 pandemic. Anecdotally, we recognize that several institutions have implemented similar measures. However, to our knowledge, there are no data comparing the utilization of these approaches before and since the pandemic.
METHODS

Environment

Clinical research are basic tenets at Mayo Clinic. Research is conducted at main campuses in Rochester, Minnesota; Scottsdale and Phoenix, Arizona; and Jacksonville, Florida, and the Mayo Clinic Health System (in Minnesota, Wisconsin, and Iowa). All campuses use an integrated electronic health record (EHR) system (Epic, Verona, Wisconsin) for clinical practice and research. The Mayo Clinic IRB serves as the IRB of record for over 95% of studies conducted at Mayo Clinic. For the remainder, an external IRB serves as the IRB of record.

Study Design

This study covered the period from March 1st 2019 to December 31st 2020. Several measures were implemented to mitigate the impact of the COVID-19 pandemic on clinical trials at Mayo Clinic. This study evaluated the effects and the resultant adaptations of the pandemic on the use of electronic consent, remote patient visits, and remote study monitor visits. These metrics were compared before and after the onset of the pandemic and implementation of COVID restrictions on the conduct of research at Mayo Clinic that were initially implemented on March 18, 2020, that is prior to stay-at-home orders issued by the state government in Minnesota (March 27, 2020), Arizona (March 31, 2020), and Florida (April 3, 2020). In order to standardize data analysis across all 3 primary Mayo Clinic sites in Arizona, Florida, and Minnesota with varying stay-at-home orders, the same cutoff date (ie, March 1, 2020) was used to compare pre- and post-COVID-19 data.

Informed Consent

Participants consent to participate in clinical research through the Participant Tracking System (PTrax) application (Mayo Clinic). The consent form is automatically sent into the patient EHR. PTrax enables the study team members the ability to track the status of all participants in real time. The status identifies the stage of participation in the study life cycle. Arranged in chronologic order, the
main statuses are enrolled (ie, after informed consent but prior to screening tests), accrued (ie, after screening tests have been completed), completed (ie, all study-related activities have been completed), and withdrawn. The accrued status is further categorized as active intervention (ie, after the primary intervention has commenced) and long-term follow-up (ie, after study-related treatments and procedures are completed and patients are under follow-up).

All participants are provided with a hard copy of the consent form. Electronic consent requires a device (eg, tablet) and a conversation, either in the physical presence (ie, for on-site, in-person consent) or remotely (ie, through video or telephone) between the person authorized to obtain consent or assent or Health Insurance Portability and Accountability Act (HIPAA) authorization from the potential participant. Neither the electronic consent nor the remote consent option is routinely granted when studies are approved by the IRB unless the study team requests permission from the IRB to use these options. Once approved, consent forms can be shared electronically with participants. The process is facilitated by integration between PTrax and DocuSign (DocuSign). Participants can consent by clicking the link, review each page, and mark their signature.

The electronic option, which was introduced in December 2013, has evolved over time. Between December 2013 and August 2019, it was only used to consent participants on-site. In August 2019, the IRB approved remote electronic consenting, which is accomplished with an email link also facilitated by DocuSign. An enhancement introduced in April 2021 allows both the participant and the person obtaining consent to electronically sign the consent form. PTrax keeps track of whether participants were consented onsite or remotely.

Data Analysis

PTrax was used to compute the number of new participants consented to every research study by hard copy and electronic means. During the COVID-19 pandemic, some participants were reconsented due to a change in study procedures due to COVID-19 pandemic. Hence, only participants
who were initially consented to a study were considered for this analysis. A few participants may participate in 2 or more studies. Hence, the data are summarized as the number of consents rather than the number of participants. Since the remote electronic consent option was introduced in August 2019, we allowed 2 months (ie, August and September 2019) for study teams to familiarize themselves with the external electronic consent option. Hence, for this analysis, the pre-COVID period was between October 1 2019, and February 28, 2020, and the post-period was between March 1, 2020, and July 31, 2020.

**Study Visits**

Where feasible, some in-person study-related visits were replaced with telephone or video visits after the pandemic began. During a video visit, patients connect to their provider or care team through a HIPPA-compliant video connection enabled through patient-specific online portal to medical services. The metrics for virtual visits were available and analyzed from July 2019 to December 2020. Pre- and during-COVID data were analyzed, respectively, between July 1, 2019, and February 28, 2020, and between March 1, 2020, and December 31, 2020.

**Remote Study Monitor Visits**

In April 2019, Mayo Clinic implemented the EpicCare Link application (Epic, Verona Wisconsin) which is compliant with 21 CFR Part 11 and allows study monitors to review the EHRs of study participants and verify compliance with the protocol. Study monitors also received access to other relevant documents such as source documentation that is housed in the EHR, via a secure file sharing solution, Microsoft SharePoint (Microsoft Corp). We analyzed the number of requests for remote study monitor visits over 10 months before (ie, between May 1, 2019, and February 28, 2020) and 10 months after March 1, 2020 (ie, between March 1, 2020, and December 31, 2020). When these data were analyzed, the number of study and patient records released in the Epic EHR for remote
Statistical Analysis

Data for electronic consent were summarized as the number of consented participants for all studies—non-trials and trials—and the proportions consented on-site and remotely. The number of remote participant visits and requests for remote study monitor visits were also analyzed before and during the COVID-19 pandemic. For all variables, pre- vs post-COVID periods were analyzed by evaluating point estimates (e.g., just before [February 2020] versus during the pandemic [December 2020]) and by comparing monthly averages with 2-sample t tests. These variables were averaged every month and then across the pre- and during-COVID periods. Data are summarized as Mean (SD). Statistical analysis was performed with Microsoft Excel (Microsoft).

RESULTS

At the beginning (May 2019) and end (December 2020) of this study period, there were 1,492 and 1,995 studies, respectively, with active participants on a research study. The number of studies with active participants increased from an average of 1,642 (103) studies during the pre-COVID period (May 2019 to February 2020) to 1,869 (68) studies per month ($P<.001$) during the COVID period (March to December 2020) (Figure 1). During this timeframe, 121,691 consent forms were signed for participation in a research study, 101,332 (83%) for a non-trial and 20,359 (17%) for a clinical trial (Figure 1).

Enrollment of New Participants: Overall and Electronic Consent

Between May 2019 and February 2020, the number of new consents signed for all studies, which includes clinical trials and non-trials, was relatively stable, averaging 5,878 ± 618 consents per month (Figure 1, Table 1). Coincident with the pandemic, the number of consents declined
precipitously to 3,483 and 719 per month in March and April 2020 (Table 1). Thereafter, these numbers steadily increased to 11,572 consents per month in November 2020.

Just prior to the pandemic (February 2020), 1,300 of 5,248 consents (25%) in all studies were completed electronically (Figure 2, Table 1). In December 2020, the corresponding proportion had increased to 6,463 of 9,446 consents (68%). Between the pre- (May 2019 to February 2020) and during-COVID periods (March to December 2020), the proportion of patients who were electronically consented increased from 22 (2)% to 45 (20)% (P=.001).

Electronic consent took place on site or remotely. In February 2020, 1,214 (23%) and 86 (2%) of all 5,248 consents were executed electronically on-site and remotely, respectively (Figure 2, Table 1). In December 2020, the corresponding numbers were 1,223 (13%) and 5,297 (56%) of 9,446 participants. Averaged over the entire pre- (May 2019-February 2020) and post-COVID epochs (March-December 2020), the proportion of remote electronic consents increased from 0.3 (0.5) to 29 (21)% (P<.001).

Comparison of On-site Versus Remote Electronic Consent in Clinical Trials and Non-Trials

Among participants in a non-trial, the proportion who were electronically consented increased from 24% in the pre-COVID period (October 2019-February 2020) to 59% in the during-COVID period (March-December 2020) (P=.001). Among clinical trial participants, the proportion who were electronically consented nearly doubled from 13% in the pre- (October 2019-February 2020) to 28% in the during-COVID period (March-December 2020) (P=.01). The utilization of electronic consent increased to a greater extent in non-trials (25 [19]%) than clinical trials (11 [9]%) (P=.055). The proportion of participants who were electronically consented remotely increased from 0.4 (0.7)% to 32 (22)% (P=.0002) in non-trials and from 0.0 to 8 (5)% in clinical trials (P<0.01). For remote consent, the pre- and during-COVID periods were between October 2019-February 2020 and March-July 2020, respectively.
Table 2 categorizes the overall and electronic consent into minimal and greater than minimal risk studies. Because Table 2 provides overall counts for the pre- and during-COVID time periods, it does not depict the initial drop in counts between February and April 2020. However, the statistical analysis compared the per month counts across pre- and during-COVID periods, each lasting 10 months. Among minimal risk trials and non-trials, the number of all consents declined respectively by 35% \( (P=0.02) \) and 25% \( (P=0.04) \). By contrast, among greater than minimal risk trials, the number of all consents increased by 131% \( (P=0.04) \). The number and proportion of electronic consents, expressed as a proportion of all consents, increased for all study types except for minimal risk clinical trials \( (P \leq 0.03) \).

In December 2020, 2,840 of 4,428 (64%) of all consents for minimal risk and 3,217 of 4,115 (77%) of all consents for greater than minimal risk non-trials were electronically recorded. However, in that same month, only 54 of 246 (22%) of all consents for minimal risk and 191 of 618 (33%) of all consents for greater than minimal risk clinical trials were electronically recorded.

**Virtual Visits by Study Participants**

In July 2019, only 3 patients had virtual research visits. In April 2020, 541 patients had 1 or more virtual research visits; thereafter the numbers declined to 194 in December 2020 (Figure 2). The number of patients who had virtual visits increased from 3.5 ± 2.4/month to 172 ± 135/month between pre-COVID (July 2019-February 2020) and during-COVID (March to December 2020) epochs \( (P=.003) \). A majority (1252 patients or 68%) of these virtual visits used telemedicine capabilities; the remainder were video-enabled visits.

**Remote Study Monitor Visits**

Between May 2019 and February 2020, 44 ± 17 study monitors requested access for remote monitoring visits (Figure 3). Between March and December 2020, this number increased to 111 ± 74 study monitors per month \( (P=.10) \). The numbers varied considerably over time. For example, during
the during-COVID period, the number of requests ranged from a low of 58 requests in December 2020 to a peak of 312 requests in August 2020.
DISCUSSION

While the impact of COVID-19 on clinical trials and the measures taken to mitigate this have been discussed, the data are limited.\textsuperscript{3,12} Among geographically diverse sites at a single academic medical center, the number of new patients who were consented to participate in research studies declined by approximately 80% between January and April 2020, which was when the stay-at-home order was initially implemented in Minnesota. By contrast to minimal risk studies, which declined before vs during the COVID-19 periods, the number of consents for greater than minimal risk trials increased over time, probably because the latter trials are more likely to provide therapeutic options for patients. In May 2020, the enrollment of new participants began to increase. By November 2020, the enrollment of new participants was double that in February 2020. This rebound was accompanied, and likely facilitated by, an increase in the proportion of new patients who were electronically consented to participate in the study.

The Mayo Clinic IRB introduced the onsite and remote electronic consent options in January December 2013 and August 2019, respectively. In February 2020, just prior to the pandemic, only 25% of all new participants were electronically consented to a research study, of whom 24% and 1% of all participants were consented on-site and remotely. By December 2020, 68% of all consents were electronically recorded, albeit more so in non-trials (72%) than in clinical trials (29%). There are 4 possible reasons for the greater utilization of the electronic consent option in non-trials than in clinical trials. First, compared to clinical trials, a greater proportion of non-trials are minimal risk studies. The IRB permits nonvulnerable participants to be digitally consented to minimal risk studies by email. A video or telemedicine conversation is optional. By contrast, video or telemedicine consent is generally necessary for greater than minimal risk studies. The IRB permits nonvulnerable participants to be digitally consented to minimal risk studies by email. A video or telemedicine conversation is optional. By contrast, video or telemedicine consent is generally necessary for greater than minimal risk studies. For some complex greater than minimal risk studies, an in-person discussion of the risks and benefits with a hard copy consent form is preferable. Second, since the screening visit for greater than minimal risk studies typically includes laboratory tests and
other objective assessments, which are typically conducted on-site, many studies may opt to consent such participants on site. Third, the person obtaining consent signature field was not uniform. There were differences among sponsors and depending on the circumstances in which participants were consented. These differences complicated the workflow and logistics. The April 2021 enhancement to PTrax has simplified the signature process for the person obtaining consent. Finally, it is conceivable that some study teams are not familiar with the remote consent option and/or have not processed the IRB modifications necessary to enable electronic consent. Indeed, in December 2020, only 22% and 31% of all consents to minimal risk and greater than minimal risk clinical trials were electronically recorded. Hence, there is scope to expand the utilization of electronic consenting in studies. When appropriately implemented, the expansion of electronic consent is 1 of several solutions that might facilitate the inclusion of diverse populations, including those who reside far away from medical centers, in clinical trials.13

Aided by guidance from the US Food and Drug Administration and National Cancer Institute, study teams utilized virtual visits where safe and feasible to continue protocol-related activities and obviate deviations.8-10 The number of virtual (telemedicine and video) visits increased from 11 per month in February to a peak of 607 per month in April 2020. Concurrent with the relaxation in stay-at-home orders in Minnesota, Florida, and Arizona, the number of virtual visits declined to 142 per month in November 2020. Research video visits are conducted with a secure video system and must be scheduled on appointment calendars. Hence, the data for research video visits are accurate.

Some applications (eg, electronic consent and remote study monitoring) that mitigated the impact of the COVID-19 pandemic were even available prior to the pandemic. The use of video visits, which were introduced 1 week after the pandemic began, rapidly increased thereafter, similar to the rapid growth in video visits for clinical care.14 Concurrent with the relaxation in stay-at-home guidelines, the number of telemedicine, and to a lesser extent, video visits, has declined since the peak
in April 2020, perhaps partly because study teams have strived to adhere to the original study protocol. However, these virtual visits have not reverted to pre-COVID-19 levels, probably because many participants prefer the convenience, reduced expense, and increased safety of virtual visits (ie, they avoid the risk of contracting COVID-19 while travelling to a medical center). By bringing clinical trials closer to patients, virtual visits may enhance access to clinical trials, especially for minority and underserved communities that have been disproportionately affected by the pandemic. Even before the pandemic, the financial burden of participating in clinical trials was highest for patients living in low-income areas or enrolled in National Institutes of Health-sponsored trials and phase I studies. These barriers discourage patients, particularly patients with low incomes, from participating in clinical trials. Among such patients, equity programs that address the financial burden of trial participation improve participation. Sustained over time, the remote electronic consent option and virtual visits will reduce the expense of participating in clinical trials and encourage participation, especially among minority communities, in trials.

One non-peer reviewed publication suggested that on-site monitoring comprised 25% to 30% of the overall cost of conducting a clinical trial. The number of study monitors who availed of the remote monitoring option increased during the pandemic. However, this change was not significant. Currently, virtually all study monitor visits are conducted remotely. In addition to saving time and travel expenses for study monitors, remote monitoring also saves study staff the expense of chaperoning monitors during visits. In addition to remote monitoring, site initiation visits are also largely conducted remotely.

In addition to these measures, study teams were provided detailed guidance on measures to facilitate work from home, conducting meetings with an online meeting platform, reporting requirements, scheduling video and telephone appointments, arranging for remote laboratory testing, and shipping medications to patients. Study protocol deviations were documented with an Epic script.
that had prefilled dropdown options in the patient’s EHR. These and other measures were widely disseminated among study teams. The IRB stipulated that research participants did not have to be reconsented during the pandemic unless the changes to the research are such that the original consent is no longer valid, which would require a modification to be submitted and approved by the IRB. Participants were notified of changes to the research via a letter or other form of communication (email, telephone, virtual meeting). Investigators were not required to report these changes to the IRB unless the form of communication was a permanent change to the consent process.

**Limitations**

Because some participants, likely few, may have participated in more than 1 study, the counts are summarized as the number of consents rather than the number of participants. The number of telemedicine visits is likely an underestimate because not all such visits are scheduled on appointment calendars. Data for remote monitor visits was limited because the data were purged from the system before we undertook this review.

**Conclusions**

COVID-19 disrupted the status quo in clinical research and provided a catalyst to hasten the adoption of electronic and other solutions for clinical trials. Sustained in the long term, these solutions may foster participation in clinical trials and reduce participant burden, thereby increasing recruitment and retention to trials.
Table 1. Temporal Trends in the Utilization of Electronic Consent in Research Studies Between 2019 and 2020

| Month       | All consent s, No. | Electronic consent for all studies<sup>a</sup> | Consents for non-trials<sup>a</sup> | Consents for trials<sup>a</sup> |
|-------------|-------------------|-----------------------------------------------|-----------------------------------|-------------------------------|
|             |                   | Internal and external, No. (%) | External, No. (%) | Total, No. | Total electronic, No. (%) | External electronic, No. (%) | Total, No. | Total electronic, No. (%) | External electronic, No. (%) |
| May 2019    | 6,319             | 1,211 (19) | 0 (0) | 5,089 | 1,137 (22) | 0 (0) | 1,230 | 74 (6) | 0 (0) |
| June 2019   | 5,939             | 1,159 (20) | 0 (0) | 4,799 | 1,055 (22) | 0 (0) | 1,140 | 104 (9) | 0 (0) |
| July 2019   | 6,046             | 1,356 (22) | 0 (0) | 4,909 | 1,219 (25) | 0 (0) | 1,137 | 137 (12) | 0 (0) |
| August 2019 | 5,832             | 1,330 (23) | 5 (0) | 4,775 | 1,195 (25) | 5 (0) | 1,057 | 135 (13) | 0 (0) |
| September 2019 | 5,854           | 1,076 (18) | 7 (0) | 4,626 | 947 (20) | 7 (0) | 1,228 | 129 (11) | 0 (0) |
| October 2019 | 7,125             | 1,547 (22) | 10 (0) | 5,827 | 1,332 (23) | 10 (0) | 1,298 | 215 (17) | 0 (0) |
| November 2019 | 6,029            | 1,274 (21) | 14 (0) | 4,925 | 1,113 (23) | 14 (0) | 1,104 | 161 (15) | 0 (0) |
| December 2019 | 4,805            | 1,212 (25) | 23 (0) | 3,812 | 1,025 (27) | 22 (1) | 993 | 187 (19) | 0 (0) |
| January 2020 | 5,586             | 1,315 (24) | 43 (1) | 4,520 | 1,163 (26) | 43 (1) | 1,066 | 152 (14) | 0 (0) |
| February 2020 | 5,248            | 1,300 (25) | 86 (2) | 4,081 | 1,083 (27) | 86 (2) | 1,167 | 217 (19) | 0 (0) |
| March 2020   | 3,483             | 912 (26) | 170 (5) | 2,820 | 828 (29) | 169 (6) | 663 | 84 (13) | 0 (0) |
| April 2020   | 791               | 113 (14) | 80 (10) | 624 | 102 (16) | 72 (12) | 167 | 11 (7) | 6 (4) |
| May 2020     | 2,748             | 567 (21) | 176 (6) | 2,252 | 526 (23) | 155 (7) | 496 | 41 (8) | 18 (4) |
| Month       | New Consents | New Subjects | New Patients | New Donors | New Tissue | New Blood | New Biorepository | New Other |
|-------------|--------------|--------------|--------------|------------|------------|-----------|--------------------|-----------|
| June 2020   | 5,261        | 2,134 (41)   | 1,157 (22)   | 4,369      | 1,938 (44) | 1,078 (25) | 892                | 196 (22)  |
| July 2020   | 5,538        | 2,476 (45)   | 1,421 (26)   | 4,435      | 2,154 (49) | 1,330 (30) | 1,103              | 322 (29)  |
| August 2020 | 6,720        | 3,416 (51)   | 1,526 (23)   | 5,647      | 3,100 (55) | 1,429 (25) | 1,073              | 316 (29)  |
| September 2020 | 7,212     | 3,645 (51)   | 2,432 (34)   | 5,995      | 3,194 (53) | 2,260 (38) | 1,217              | 451 (37)  |
| October 2020 | 10,137       | 6,205 (61)   | 4,956 (49)   | 8,746      | 5,759 (66) | 4,821 (55) | 1,391              | 446 (32)  |
| November 2020 | 11,572      | 8,458 (73)   | 7,338 (63)   | 10,498     | 8,036 (77) | 7,173 (68) | 1,074              | 422 (39)  |
| December 2020 | 9,446        | 6,463 (68)   | 5,297 (56)   | 8,583      | 6,210 (72) | 5,081 (59) | 863                | 253 (29)  |

* All percentages are expressed as a proportion of the total new consents.
Table 2. Comparison of All and Electronic Consents Before and During the COVID-19 Pandemic

| Period       | Non-trial                     | Clinical trial                  | Non-trial                     | Clinical trial                  |
|--------------|-------------------------------|---------------------------------|-------------------------------|---------------------------------|
|              | Minimal risk                  | Greater than minimal risk       | Minimal risk                  | Greater than minimal risk       |
|              | All, No.                      | All, No.                        | All, No.                      | All, No.                        |
| Pre-COVID    | 35,532                        | 11,831                          | 3,139                         | 8,283                           |
|              | 8,489 (24)                    |                                 | 2,025 (17)                    |                                 |
|              | 498 (16)                      |                                 | 988 (12)                      |                                 |
| During COVID | 26,691                        | 27,279                          | 2,054                         | 6,887                           |
|              | 11,169 (42)                   |                                 | 19,623 (72)                   |                                 |
|              | 449 (22)                      |                                 | 2,049 (30)                    |                                 |
| Change (%)   | -25                           | -35                             | -17                           | -10                             |
|              | 32                            |                                 | 869                           | 107                             |
| P value      | 0.04                          | 0.04                            | 0.02                          | 0.13                            |
|              | 0.03                          |                                 | <.0001                        | 0.09                            |
|              | 0.01                          |                                 | 0.01                          |                                 |

a Values are 10 month averages each pre- (May 2019-February 2020) and during-COVID (March to December 2020).
b Expressed as a proportion of all studies in this category.
c ((During – Before)/Before)*100.
d Two-sample t test for actual values (all consents) or proportion of electronic (ie, electronic/overall) consents during pre- vs during-COVID.
FIGURE LEGENDS

**Figure 1.** Temporal trends in the number of clinical research studies and enrollment of new participants at Mayo Clinic between May 2019 and December 2020.

**Figure 2.** Temporal trends in electronic consenting for clinical research studies between May 2019 and December 2020. Digital consents include on site and remote digital consents. The difference between all and digital new consents represents the number of hard copy consents.

**Figure 3.** Temporal trends in studies (left panel) and participants (right panel) with virtual visits between July 2019 and December 2020. Virtual visits include video and telemedicine visits.
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FIGURE 2

[Graph showing trends in new consents from May 2019 to December 2020, with different lines representing different categories of consent: New consents (all), New consents (digital), New consents (on site digital), and New consents (remote digital).]
