

1 **Supplement**

2 **Trial Protocol and Statistical Analysis Plan**

3 **Effect of a Digital Engagement Strategy on Healthcare Worker Mental Health and Well-being: A**
4 **Randomized Controlled Trial**

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Original Study Protocol

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64 **1. Abstract**

65 Early in the pandemic, our team developed and implemented Penn Cobalt across the University of
66 Pennsylvania Health System which spans six acute-care hospitals and employs over 43,000 individuals.
67 Cobalt is a web-based platform that curates mental health and wellness content and provides
68 connection to group and individual support. Using validated mental health assessments, Cobalt triages
69 users to the right level and type of support across three categories: In the studio synchronous group
70 sessions, On your time asynchronous content, and 1:1 support. The 1:1 support represents a stepped
71 care model of mental health services and includes peer support, resilience coaches offering
72 psychological first aid, psychotherapists, and psychiatrists. Cobalt's embedded scheduling and telehealth
73 capabilities also provide HIPAA-compliant mental health care in a convenient, patient-centered model.
74 Cobalt content continuously adapts and evolves through crowdsourced feedback to encompass locally
75 defined and sensitive resources (e.g. addressing racial trauma). Over the first 7 months, Cobalt has had
76 over 140,000-page views and 18,300 unique users engaging with its content and support. The platform
77 identified 111 HCWs reporting thoughts of self-harm and connected those individuals with a mental
78 health provider for support and evaluation within 24 hours.

79
80 **1. Background**

81 Epidemics are often associated with significant mental health consequences to society. Large-scale
82 disasters, whether traumatic (e.g., the World Trade Center attacks or mass shootings), natural (e.g.,
83 hurricanes), or environmental (e.g., Deepwater Horizon oil spill), are often accompanied by increases in
84 depression, posttraumatic stress disorder (PTSD), substance use disorder, and a broad range of other
85 mental health and behavioral disorders, domestic violence, and child abuse. For example, prior work
86 showed that 5% of the population affected by Hurricane Ike in 2008 met the criteria for major
87 depressive disorder in the month after the hurricane; 1 out of 10 adults in New York City showed signs
88 of the disorder in the month following the 9/11 attacks. And almost 25% of New Yorkers reported
89 increased alcohol use after the tragic attacks. Communities affected by the Deepwater Horizon oil spill
90 showed signs of clinically significant depression and anxiety. The SARS epidemic was also associated with
91 increases in PTSD, stress, and psychological distress in patients and clinicians. For such events, the
92 impact on mental health can occur in the immediate aftermath and then persist over long time periods.
93 The rates of stress and burnout were high in health care workers prior to the pandemic and those rates
94 have persisted or increased. In March of 2020, COVID-19 emerged as a global pandemic resulting in
95 acute stressors directly impacting an already vulnerable and strained health care system. Healthcare
96 workers (HCWs) are facing unique challenges during the COVID-19 pandemic related to rapid shifts in
97 care, strains on availability of personal protective equipment, moral injury, and concerns about risks of
98 infection. The challenges confronting HCWs continue outside of work including childcare responsibilities,
99 career trajectory and concern for employment status with dynamically shifting practice models and
100 patient volumes. The mental health burdens of frontline HCWs began to emerge in early retrospective
101 studies from China and Italy; with early reports of increases in clinician suicide due to the pandemic.
102 HCWs are predicted to face repeated acute triggering events throughout the long period of
103 disillusionment we now find ourselves in as we slowly inch towards reconstruction and recovery with
104 the COVID-19 pandemic. Additional HCW stress is associated with the real or perceived risk of
105 contracting COVID-19 or spreading it to loved ones. A 2020 MMWR report on occupation type and job
106 setting of HCWs with COVID-19 showed that the relative percentage of cases was high in nurses (1742,
107 29.5%), environmental services (EVS) (330, 5.6%), physicians (190,3.2), and respiratory therapists (44,
108 0.7%). COVID-19 has also affected HCWs across demographics with higher rates of death in
109 underrepresented minorities. Among HCW with COVID-19 the median age was 41 years and 79% were
110 females. For the 69,678 (69%) of cases with available data on race and ethnicity the distribution was
111 Whites (47%), Blacks (26%), Hispanics (12%) Asians (9%). Compared with COVID-19 survivors, non-

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112 survivors were more likely to be older (median age 62), male (38% vs. 22%), Asian (20% vs. 9%), or Black
113 (32% versus 25%). The increased exposure to COVID-19 may also limit physical contact of HCW with
114 usual support networks and systems (e.g. family or faith-based groups) or lead to increased stress
115 because of home based caregiving for elderly or immunocompromised family members. HCWs
116 identifying as Black, indigenous, or of color are a vulnerable population. Prior reports support that black
117 adults are approximately 10% more likely to report psychological distress when compared with white
118 adults. Data from the Health and Human Services Office of Minority Health also shows that black adults
119 are more likely than white adults to report hopelessness, sadness, and feeling like everything is an
120 effort. There are significant barriers to accessing mental health care for black adults and it is estimated
121 that only one in three black adults who need mental health care receive it. Many reasons contribute to
122 these disparities including: costs of care, stigma associated with care, provider bias, lack of knowledge
123 regarding available mental health therapies, and the lack of minority mental health professionals. For
124 those who do receive care, the care is often of lower quality and not culturally aligned. Black HCWs have
125 historically been subject to racism, discrimination, and inequity--and the national events centered
126 around racial injustice coupled with COVID-19 have likely exacerbated mental health and well-being in
127 measurable and sustained ways. Minority HCWs were already strained, often working within settings
128 where they themselves are subject to microaggressions, overt acts of racism, structural racism and are
129 direct observers of racial inequities in patient care leading to significant disparities in morbidity and
130 mortality. Racial minorities are also disproportionately in jobs with high exposure risk including grocery
131 stores, public transportation, factories, and health care facilities. A meta-analysis of 293 studies
132 identified that racism significantly contributed to worse mental and physical health. Based on findings
133 from more than 60 structured interviews with Black HCWs, the noted sociologist Adia Wingfield
134 summarized her findings and noted: being a Black health care worker comes with specific difficulties
135 that can easily go unnoticed. In a pandemic where Black populations are among the hardest hit, these
136 difficulties are likely being magnified exponentially. Health care systems are undoubtedly taxed, but in
137 the interest of their workers, they should consider ways they can support Black health care providers to
138 offset the kinds of burnout and stresses research indicates they are likely experiencing right now. In this
139 national emergency, health care systems may need to think past providing health care just for patients
140 and consider the health of their workers, perhaps through counseling and support groups, heeding
141 employees suggestions for how systems can be improved. The social and economic consequences of
142 COVID-19 are predicted to affect women differently than men. Prior reports support that women have
143 been more likely to lose their jobs or leave them during the pandemic due to a need to provide child and
144 elder care as well as to support home schooling. While this unpaid labor has increased, paid work
145 opportunities have also decreased for women. Increases in sexual and physical violence toward women
146 during lockdowns have also been reported. The United Nations has identified increased vulnerability of
147 female frontline workers and the need for targeted programs to specifically address their unique mental
148 health needs due to a multitude of stressors. Prior reports have also focused on female frontline
149 providers and physician researchers and threats to their professional careers, particularly academic,
150 advancement due to barriers in work productivity as a result of COVID-19. The psychological impact of
151 the delay in academic career progression (e.g. fewer grant submissions, fewer peer-reviewed
152 publications, fewer leadership opportunities) could be pronounced and long standing. Considering how
153 the pandemic has led to considerable strain on women and the unique impact on women in health care,
154 this proposal specifically focuses on evaluating if Cobalt+ will have a greater impact on women and can
155 serve as a platform for addressing inequities in mental health care for this vulnerable population.
156 COVID-19 has increased the use and application of digital technologies in health care including text
157 messaging, mobile surveys, and telemedicine. Evolving and rapidly adopted approaches in mobile
158 engagement through digital technology create scalable opportunities to assess individuals needs in real-
159 time and can be used to rapidly deploy tailored well-being and mental health interventions. This

160 approach also offers a strategy to reveal the central tendencies, distributions, and associations which, in
161 population-based studies, can immediately inform a health systems approach toward maintaining a
162 healthy workforce and lowering barriers to mental health care.

163
164 **2. Overall Objectives**

165 Through a RCT, evaluate the effectiveness of Cobalt+ on HCW depression/anxiety (primary outcome)
166 compared with Cobalt (usual care).

167
168 *2.1. Primary Aims*

169 Aim 1: Through a RCT, evaluate the effectiveness of Cobalt+ on HCW depression/anxiety (primary
170 outcome) compared with Cobalt (usual care).

171
172 Aim 2: To better understand perceptions of access to mental health care and the effectiveness of
173 Cobalt compared with Cobalt+ among HCWs through semi-structured qualitative interviews.

174
175 *2.2. Secondary Aims*

176 Secondary outcomes will include well-being, satisfaction with access to care, and measures of work
177 productivity. HTE will be explored for race and gender.

178
179 **3. Primary Outcome Variable**

180 Measures were selected based on clinical relevance, validity in the HCW population, and meaningfulness
181 to the target population. To facilitate data sharing, measures below were also identified to align with the
182 NIMH data archive when possible Depression and Anxiety: The primary outcome will be depression and
183 anxiety as measured by the Patient Health Questionnaire (PHQ-9) and General Anxiety Disorder (GAD-7)
184 respectively. PHQ-9 and GAD-7 have been validated and used in multiple studies and provide easy, simple
185 scales to quickly assess for depression and anxiety. PHQ9 is a 9-item score which ranges from 0 (least
186 depressed) to 27 (most depressed. GAD-7 is a 7- item scale which assess the frequency of anxiety
187 symptoms over the past two weeks on a 4-point Likert-scale ranging from 0 (never) to 3 (nearly every
188 day). The total score of GAD-7 ranged from 0 to 21, with increasing scores indicating more severe
189 functional impairments as a result of anxiety.

190
191 **4. Secondary Outcome Variable(s)**

192 Well-being index: The Well-being index (WBI) is a nine-question survey validated for use in HCW
193 populations and considered important to health systems in managing the well-being of their workforce.
194 Work productivity: To evaluate work productivity, we will use the World Health Organization Health and
195 Work Performance Questionnaire (HPQ) short form. The HPQ is a validated self-report instrument
196 designed to estimate the workplace costs of health problems with regard to reduced job performance,
197 absence due to sickness, and work-related injuries and accidents. We will administer the short form
198 which is an 11-question survey focused on absenteeism and presenteeism. Satisfaction with care: Client
199 Satisfaction with Care (CSQ)-8 is a brief 8-item unidimensional well-established scale for assessing
200 patients satisfaction with overall outpatient health care. It has been shown to be reliable and valid in
201 assessing care across a range of settings.

202
203 **5. Study Design**

204 *5.1. Phase*
205 Not applicable

206

207 5.2. *Design*

208 We will conduct a prospective two-armed randomized control trial to test the effect of tailored mental
209 health support on self-reported HCW mental health (anxiety and depression) during the response and
210 recovery phases of the COVID-19 pandemic. The control group will have access to Cobalt which is usual
211 care for all Penn Medicine employees. The Cobalt platform is web-based and is accessible from any
212 device or desktop. Cobalt uses contextual surveys and evidence-based assessments to triage individual
213 users to curated content and appropriate group or individual support. The current, and usual care,
214 model is a digital version of what exists at other institutions where resources are available for staff to
215 access wellness and mental health services. The usual care Cobalt model requires staff to personally
216 initiate multiple steps: 1) identify a personal need for support, 2) know where to seek support and care,
217 3) schedule an appointment, and 4) attend the appointment. In this context, the individual has to pull
218 the resources they need and there may be several barriers to completing each step. This is particularly
219 relevant as mental health conditions can compromise insight, motivation, and decision making, thereby
220 making self-directed engagement in care (pull) more challenging. The study will be single-blinded and
221 the study biostatistician will determine when to unblind the study. Given that the study compares the
222 same process delivered as either a pull (usual care = Cobalt) or a push (intervention = Cobalt +) we
223 believe risk is low. Nevertheless, we will engage a 3-member independent Data and Safety Monitoring
224 Board to oversee the trial. In accordance with conventional practices, we will not identify members in
225 advance so as not to disqualify potential proposal reviewers. To assess factors that may contribute
226 toward accessing and using mental health resources between Cobalt versus Cobalt+, we will conduct
227 semi-structured interviews (telephone or virtual video conference) with HCWs enrolled in Aim 1.
228 Standardized interview guides will be created using the consolidated framework for implementation
229 research (see Appendix) to ensure uniformity in how and what questions are asked of each group. Some
230 questions within the guides will be the same between those in the traditional care arm (Cobalt) versus
231 intervention (Cobalt+) to allow for comparison. We will interview up to 80 HCWs from Penn Medicine in
232 order to understand the attitudes and decision-making involved in mental health strain during COVID-
233 19. We will recruit across both arms of the Aim 1 study to investigate HCW in usual care Cobalt (n=40)
234 and from those in the intervention arm Cobalt+ (n=40). Using data from Aim 1, we will use a deviance
235 sampling approach to identify HCW from the top and bottom 25% percentiles of anxiety and depression
236 scales. This deviant selection is intentional to maximize the potential to identify themes unique to high
237 or low levels of mental health strain. Individual scale scoring will not be revealed in order to limit
238 responder bias, increase response rates and avoid attribution bias. We will recruit HCWs using a series
239 of e-mails (up to 4 email invitations) and text messages (up to 3 text invitations). We will contact
240 participants to obtain consent, ensure study procedures are described, answer questions and offer a \$50
241 gift card for their time. The goal is to conduct 80 audio-recorded semi-structured interviews (~20-30
242 minutes). Interview questions will be aligned with themes from our preliminary studies and focus groups
243 with front line healthcare workers early in the pandemic. Participants will be contacted one month
244 following the end of the Aim 1 intervention period and consented via WTH. Participants will not be
245 informed as to why they were selected and confidentiality will be maintained. There is variability in how
246 individuals experience anxiety, depression, stress and overall well-being. Understanding how HCWs
247 think about these emotions, their physical and mental states of being, and the decisions to access and
248 utilize mental health resources are essential to the design of interventions to facilitate and support the
249 workforce. Understanding how HCWs approach mental health assessments for themselves and the
250 stigma associated with care is also critical in designing programs that are acceptable and used.
251 Investigation of the factors that impact mental health care in HCWs can be supported by semi-

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252 structured interviews which ask open-ended questions and allow participants to describe key attitudes,
253 decision-making processes, and emotions that are otherwise difficult to assess.

254

255 *5.3. Study Duration*

256 The RCT will compare this pull model with a new model, the intervention named Cobalt+, which will
257 proactively reach out to and engage individuals in order to reduce barriers in identifying a need for and
258 accessing mental health care. The intervention group will have access to the same Cobalt resources as
259 those in the usual care group but will also receive a comprehensive suite of services including: 1)
260 monthly automated text messaging reminders and links to Cobalt resources 2) intermittent mental
261 health assessments (PHQ-9, GAD-7) at enrollment, month 2, month 4 and month 6 which triage
262 individuals to an opt-out appointment with a resilience coach, psychotherapist, or psychiatrist based on
263 their results. Of note, all employees will have access to Cobalt whether they are in the study or not.
264 Through the proposed RCT we will evaluate whether the intervention, a proactive model of care delivery
265 (Cobalt+) impacts the primary outcome measure (depression and anxiety) and secondary outcome
266 measures (well-being, satisfaction with access to care, and measures of work productivity [e.g.
267 absenteeism]).

268

269 *5.4. Facilities*

270 The research team is highly experienced and well-positioned to execute this project rapidly and across
271 departments and hospitals within Penn Medicine. Team members have worked closely on many clinical
272 and research programs, conducted clinical trials using mobile and digital tools and platforms, and
273 conducted trials specifically in the target vulnerable population, HCW. Pilot work from this team has led
274 to multiple peer-reviewed publications in wellbeing, mental health, and deploying digital tools and
275 platforms. We have enthusiastic support from Penn Medicine and departmental leadership in
276 developing strategies to identify, support, and protect HCW well-being and mental health. Our team is
277 interwoven within the frontline clinical workforce. The research team brings together expertise in real-
278 time patient- centered engagement using digital tools (Merchant, Agarwal, Asch), digital health
279 (Merchant, Agarwal), well-being research (Bellini, Asch, Agarwal, Wolk), survey and qualitative methods
280 (Shea), advanced biostatistics and computational methods (Mitra) and innovations in health systems
281 (Asch, Merchant, Agarwal). Our team also has integral roles in Penn Medicine leadership which can help
282 with project stewardship and uptake: PI (Merchant) serves as the Penn Medicine Associate Vice
283 President of Digital Health, Co-I (Bellini) is the Senior Vice Dean for Academic Affairs and health system
284 lead for Cobalt, and Co-I (Asch) is the Executive Director of the Penn Medicine Center for Health Care
285 Innovation and Innovation lead for Cobalt. Additionally, Penn is an opportune venue to conduct COVID-
286 19 related research as a leader in the region in acute and virtual care during the pandemic. This proposal
287 represents a natural next step to build upon our expertise and track record of success in designing,
288 conducting, and disseminating meaningful and actionable patient and provider centered research.
289 Advisory Board and stakeholder engagement: To insure input from providers that will inform the
290 research, we will convene an advisory board representing entities from each (n=12) of the direct patient
291 care groups (e.g. physicians, nurses, certified nursing assistants, lab technicians, radiology technicians
292 physical therapists, occupational therapists, pharmacists, pharmacy technicians, patient registration
293 staff, patient intake coordinators, environmental service personnel). We have strong existing
294 relationships with these groups and will meet with them before the study initiates and then every 6
295 months thereafter for input, engagement, and feedback. Some of the members of this group will also be
296 recruitment champions identified. This step is critically important and we will work collaboratively with
297 this group for stakeholder guidance about all aspects of execution and reporting for the study.

298

299 *5.5. Key Inclusion Criteria*

300 There are no inclusion and exclusion criteria for any subpopulation based on race/ethnicity, age, gender,
301 status as a vulnerable population. Eligibility criteria for study enrollment will include: 1) age 18 years or
302 older; 2) regular, daily access to a smartphone 3) able to communicate fluently in English (as the current
303 Cobalt assessments and resources are in English at this time), 4) work at least 4 hours per week in either
304 a hospital or outpatient based settings (e.g. physicians, nurses, certified nursing assistants, lab
305 technicians, radiology technicians, physical therapist, occupational therapist, pharmacists, pharmacy
306 technicians, patient registration staff, receptionists/patient intake coordinators, environmental service
307 personnel) approximately 4 hours/week (on average 192 hours/ 48 weeks in a year) in the study time
308 frame. Eligible participants will then have an opportunity to consent to study participation. Any HCW
309 meeting these criteria will be eligible to participate in the research; we will not exclude any potential
310 participant based on a priori criteria.

311
312 *5.6. Key Exclusion Criteria*

313 1). Under 18 years of age; 2) does not have an interest in participating in a 9-month study and willing to
314 complete regular surveys; 3) does not have regular, daily access to an SMS-capable phone 4) unable to
315 communicate fluently in English (as the current Cobalt assessments and resources are in English at this
316 time), 5) does not provide direct patient care approximately 4 hours/week (on average 192 hours/ 48
317 weeks in a year) in the study time frame. 6). Not willing to provide informed consent

318
319 **6. Subject Recruitment**

320 *6.1. Target Population*

321 The population of interest for this proposal is HCWs who in the midst of COVID-19 are at increased risk
322 for mental health symptoms and conditions. We will also utilize University groups and motivated mental
323 healthcare champions to specifically promote inclusion of female and underrepresented minority HCW
324 in the RCT and qualitative aim. This focus aligns with the RFA which identifies vulnerable populations as:
325 medical personnel with direct patient care and NIH-designated health disparity racial/ ethnic minorities.
326 We specifically include a broad definition of HCWs (e.g. physicians, nurses, certified nursing assistants,
327 lab technicians, radiology technicians, physical therapists, occupational therapists, pharmacists,
328 pharmacy technicians, patient registration staff, coroners, receptionists/patient intake coordinators,
329 environmental service personnel) that are not routinely evaluated jointly and with the same
330 intervention. While much of the attention in the pandemic has been on physicians and nurses we aim to
331 focus on a broader group that is at risk for COVID-19 and mental health symptoms and conditions

332 *6.2. Subjects at Penn*

333 1,250

334
335 *6.3. Accrual*

336 To recruit potential study participants, we will send an email about the study to the entire Penn
337 Medicine employee listserv, as these individuals are the same recipients of Penn Medicine news and
338 Covid-19 updates who have received prior information about the availability of Cobalt. Emails will be
339 sent up to 5 times to this employee list. The plan to outreach to employees in this manner has been
340 approved by both Penn Medicine Human Resources and the Penn Medicine Chief Operation Officer. We
341 will specifically engage recruitment champions in the study design and for support in extending the
342 reach of the recruitment email to underrepresented minority HCWs. These recruitment champions will
343 include each Departments Vice Chair for Diversity and Inclusion to support sending the email about the
344 study to their Departments and groups within their Departments specifically focused on diversity and
345 inclusion. We will also engage Centers, Departments, and Groups at Penn Medicine to support
346 dissemination of the study announcement. These include the Office of Inclusion and Diversity, the
347 Alliance of Minority Physicians, Penn Medicine Center for Health Equity Advancement, Bold Solutions

348 Initiative, FOCUS on health and leadership for women, Penn Promotes research on sex and gender in
349 health, and the Program for Health Equity in Education and Research. Furthermore, we will recruit in-
350 person across the Penn Medicine campus such as tabling outside of prominent buildings and
351 departments (New Pavilion and cafeterias) and attend department morning huddles / meetings to
352 accommodate staff members who have limited access to their email accounts. We will also be
353 intentional about diversity of representation in the images in all study materials and highlight the
354 diversity in our project team. We base our power considerations on baseline data presented in an RCT
355 conducted by Graham et al. In their study, they report a mean baseline PHQ-9 of 14.0 (SE=5.0) and mean
356 GAD-7 of 11.6 (SE=4.6). We assume a type I error rate of 2.5% (.05/2) to account for the two separate
357 outcomes that we will be evaluating. We aim to enroll 1250 participants with the anticipation that there
358 will be 20% attrition.

359

360 *6.4. Patient Subject Recruitment*

361 To recruit potential study participants, we will send an email about the study to the entire Penn
362 Medicine employee listserv, as these individuals are the same recipients of Penn Medicine news and
363 Covid-19 updates who have received prior information about the availability of Cobalt. Emails will be
364 sent up to 5 times to this employee list. The plan to outreach to employees in this manner has been
365 approved by both Penn Medicine Human Resources and the Penn Medicine Chief Operation Officer (see
366 letters of support). Exploratory Aim1 specifically seeks to determine if the effect of the intervention
367 varies across patient subgroups (e.g. race and gender) as we recognize the importance of evaluating the
368 effect of Cobalt in these specific populations. We will specifically engage recruitment champions in the
369 study design and for support in extending the reach of the recruitment email to underrepresented
370 minority HCWs. These recruitment champions will include each Departments Vice Chair for Diversity and
371 Inclusion to support sending the email about the study to their Departments and groups within their
372 Departments specifically focused on diversity and inclusion. We will also engage Centers, Departments,
373 and Groups at Penn Medicine to support dissemination of the study announcement. These include the
374 Office of Inclusion and Diversity, the Alliance of Minority Physicians, Penn Medicine Center for Health
375 Equity Advancement, Bold Solutions Initiative, FOCUS on health and leadership for women, Penn
376 Promotes research on sex and gender in health, and the Program for Health Equity in Education and
377 Research. We will also be intentional about diversity of representation in the images in all study
378 materials and highlight the diversity in our project team. To promote retention, participants will be
379 emailed up to 4 times and texted (up to three times) to nudge survey and assessment completion. For
380 compensation, each participant will receive up to \$200: \$50 at enrollment, \$75 at 6 months and \$75 at 9
381 months for 3 total surveys. Submission for subject reimbursement will occur immediately upon
382 completion of surveys and assessments and occur through the Way to Health platform which facilitates
383 timely payment.

384

385 *6.5. Subject Compensation*

386 To promote retention, participants will be emailed up to 4 times and texted (up to three times) to nudge
387 survey and assessment completion. For compensation, each participant will receive up to \$200: \$50 at
388 enrollment, \$75 at 6 months and \$75 at 9 months for 3 total surveys. Submission for subject
389 reimbursement will occur immediately upon completion of surveys and assessments and occur through
390 the Way to Health platform which facilitates timely payment. Each participant will receive \$50 for
391 interview completion.

392

393 **7. Study Procedures**

394 *7.1. Consent Process*

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395 To recruit potential study participants, we will send an email about the study to the entire Penn
396 Medicine employee listserv, these individuals are the same recipients of Penn Medicine news and
397 COVID-19 updates who have received prior information about the availability of Cobalt. Emails will be
398 sent up to 4 times to this employee list. This proposal includes a letter of support from the Penn
399 Medicine Director of Human Resources and Penn Medicine Chief Operation Officer indicating support
400 for the project and access to these listservs. Participants will provide electronic informed consent before
401 participation in the study. The electronic consent form is hosted on Way to Health, HIPAA Compliant
402 Platform. Participants will be notified that enrollment is voluntary and declining to participate will not
403 change their access to Cobalt or have an impact on their employment. Participants will be consented
404 with ample time to discuss consent. Participants will be given contact information (including telephone
405 and email) for the principal investigator (Dr. Merchant), and the University of Pennsylvania IRB to
406 address any potential concerns. A detailed Manual of Operations will be developed for the study and
407 procedures will be designed to ensure efficient and prompt updating. Our project is designed to function
408 entirely remotely (recruitment, consent, enrollment, survey completion) All study participants read and
409 review the informed consent document independently on Way to Health but research team members
410 are readily available to discuss the form and answer questions via email or telephone communications,
411 all noted on the instructions of the informed consent document on Way to Health. All investigators have
412 experience in developing a manual of operations. All study staff will undergo a thorough training and
413 certification procedure prior to protocol implementation, including CITI Course in the Protection of
414 Human Research Participants online training in research ethics. The initial training will be conducted by
415 the PI and will include an overview of the study, detailed explanation of the study protocol, and hands-
416 on practice of specific protocol components. All study staff will be observed conducting randomly
417 selected protocol duties at least twice annually and evaluated using specifically designed checklists.

418
419 *7.1.1.1. Waiver or Alteration of Informed Consent*

420 Not applicable

421
422 *7.1.1.2. Minimal Risk*

423 Since we are recruiting Penn Medicine employees, the informed consent highlights how their Penn
424 Medicine employer, director, supervisor, or co-worker may be an investigator in this research study. The
425 document also includes language on how if the individual chooses not to participate, there will be no
426 loss of benefits to which they are otherwise entitled. Their employment is not in jeopardy based on their
427 enrollment status. Given that the study compares the same process delivered as either a pull (usual care
428 = Cobalt) or a push (intervention = Cobalt +) we believe risk is low. Nevertheless, we will engage a 3-
429 member independent Data and Safety Monitoring Board to oversee the trial. In accordance with
430 conventional practices, we will not identify members in advance so as not to disqualify potential
431 proposal reviewers. All subjects will be consented for participation and will have the ability to withdraw
432 at any time. There is minimal risk to the participants as Penn Cobalt will triage patients accordingly to
433 level of services for mental health support. All qualitative results will be de-identified and any collected
434 PHI data will be stored securely and separately. Participants can elect to not participate in the study
435 without any consequences. Participants can also opt-out of participating at any time. All employees have
436 access to Cobalt and associated services; participants in the intervention arm may be less likely to
437 experience risks associated with the research because they are receiving pushed services designed to
438 reduce barriers to access of mental health services.

439 *7.1.1.3. Impact on Subject Rights and Welfare*

440 We will be obtaining informed consent from patients who have been provided a thorough explanation
441 of the study and the opportunity to ask any questions about study participation. Patients will be read
442 the entire consent and given the option to participate.

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7.1.1.4. *Waiver Essential to Research*

All participants will be recruited through remote procedures.

7.1.1.5. *Written Statement of Research*

This study does not operate under a written statement of research.

7.2. *Procedures*

We will conduct a prospective two-armed randomized control trial to test the effect of tailored mental health support on self-reported HCW mental health (anxiety and depression) during the response and recovery phases of the COVID-19 pandemic. The control group will have access to Cobalt which is usual care for all Penn Medicine employees. The Cobalt platform is web-based and is accessible from any device or desktop. Cobalt uses contextual surveys and evidence-based assessments to triage individual users to curated content and appropriate group or individual support. The current, and usual care, model is a digital version of what exists at other institutions where resources are available for staff to access wellness and mental health services. The usual care Cobalt model requires staff to personally initiate multiple steps: 1) identify a personal need for support, 2) know where to seek support and care, 3) schedule an appointment, and 4) attend the appointment. In this context, the individual has to pull the resources they need and there may be several barriers to completing each step. This is particularly relevant as mental health conditions can compromise insight, motivation, and decision making, thereby making self-directed engagement in care (pull) more challenging. The RCT will compare this pull model with a new model, the intervention named Cobalt+, which will proactively reach out to and engage individuals in order to reduce barriers in identifying a need for and accessing mental health care. The intervention group will have access to the same Cobalt resources as those in the usual care group but will also receive a comprehensive suite of services including: 1) monthly automated text messaging reminders and links to Cobalt resources 2) intermittent mental health assessments (PHQ-9, GAD-7) at enrollment, month 2, month 4 and month 6 which triage individuals to an opt-out appointment with a resilience coach, psychotherapist, or psychiatrist based on their results. Of note, all employees will have access to Cobalt whether they are in the study or not. Through the proposed RCT we will evaluate whether the intervention, a proactive model of care delivery (Cobalt+) impacts the primary outcome measure (depression and anxiety) and secondary outcome measures (well-being, satisfaction with access to care, and measures of work productivity [e.g. absenteeism]).

8. Analysis Plan

We will conduct an intent to treat (ITT) analysis. The ITT analysis will include all randomized participants in the groups to which they were randomly assigned. Baseline demographic and clinical characteristics will be reported as frequency and percent for categorical variables and median and distribution for continuous variables. We will compare baseline characteristics between intervention and control arms using t-tests for continuous variables and chi-squared tests for categorical variables. The goal of these comparisons will be to determine if the two arms are balanced on baseline variables after randomization. Our primary analysis will focus on the difference in PHQ-9 and GAD-7 scores at 6 months between the two arms. We will estimate and test differences in means between arms using two-sample t-tests and generalized linear models that account for baseline measurements of PHQ-9 and GAD-7. Missing data will be assessed for patterns and multiple imputation will be used if deemed appropriate. Baseline covariates that are found to be imbalanced between arms may be adjusted for in the model if they were deemed to be potential confounders a priori to adjust for potential confounding and for efficiency gain. We will use all available PHQ-9 and GAD-7 scores on eligible patients from randomization

491 through the last observation. A $p < 0.05$ will be deemed statistically significant but emphasis will be placed
492 on point estimates and confidence intervals. Secondary outcomes of mental healthcare utilization,
493 satisfaction with connection to services, and qualitative feedback on mobile engagement will also be
494 modeled using GEE with mean models specified based on the distribution of the specific outcome (e.g.
495 Poisson or negative binomial for number of mental healthcare visits, logit for binary responses).
496 Potential associations between system-level or regional level case burden and PHQ-9 and GAD-7 scores
497 at baseline and over-time will be assessed with generalized linear models and GEE. Exploratory Aim 1:
498 Statistical approach: The statistical approach for studying HTE will be to test for the statistical
499 interaction between the intervention and race and separately by gender in the GEE models described
500 above. Although our study was not designed specifically to detect HTE, if 20% of our trial participants
501 are Black (based on targeted recruitment efforts), our study will achieve 80% power (assuming type I
502 error of 0.05) to detect a 1.8 difference in mean GAD-7 scores and a 2.0 difference in mean PHQ-9
503 scores between arms at 6 months. We anticipate that at least 50% of participants will be female. Hence,
504 our study is powered to detect a 1.2 difference in mean GAD-7 scores and a 1.3 difference in mean PHQ-
505 9 scores between arms at 6 months among women.
506

507 Aim 2: Power: no power calculation will be performed for this qualitative aim consistent with prior
508 qualitative aims we will aim to interview 80 participants from Aim 1 and evaluate themes until
509 saturation Analysis: Using thematic analysis, we will analyze HCW interview transcripts to identify
510 recurring themes in attitudes and beliefs toward mental health, well-being, and mental health care or
511 resources. Interview audio will be transcribed and uploaded into NVivo software (available as a Penn
512 resource). In total we plan for up to 80 semi-structured interviews, or until inductive thematic saturation
513 is reached in each group meaning no new themes are emerging. Analysis of qualitative, semi-structured
514 interviews utilizes a series of systematic steps in transcribing, developing a code for thematic content,
515 and subsequent coding of interviews. A modified grounded theory approach will be used to evaluate
516 interview transcriptions. Analysis will begin shortly after the first few interviews are completed. An
517 emergent, iterative open coding process will be followed and two trained coders from the research
518 team will jointly read five transcripts and draft the outline of a codebook. Each coder will then
519 independently code five more transcripts and adjust the codebook as needed. We will review the codes,
520 resolve discrepancies and finalize coding procedures. Following adjudication of any areas of discrepancy,
521 the research team coders will be assigned batches of transcripts for independent coding, sharing 25% of
522 the transcripts in each batch for ongoing inter-rater agreement assessment. We will review coding for
523 interrater reliability, measured by Cohens kappa (0.8), and overall comprehensiveness. If a high kappa is
524 not achieved, further double coding and refining of the code will continue. This approach to coding and
525 analyzing qualitative data has been widely used. Strategies used to ensure reliability and validity in the
526 qualitative data will include a comprehensive audit trail, checks between coders, team debriefing, and
527 corroboration of findings across participants.

528 **9. Subject Confidentiality**

529 The research team will exercise extreme caution with identifiable private information. Patients
530 randomized to the intervention arm will receive weekly messages from Way to Health. In the patients
531 informed consent, they are instructed and agree by signing the document that they will not disclose
532 personal health information (PHI) on the Way to Health texting platform and only respond to the text
533 message prompts. When patient participants (both control and intervention) text into the Way to Health
534 or complete a survey, the research team will receive email notification immediately. The research team
535 is instructed to review the message within 1-4 hours of delivery, Monday through Friday, 8 am to 5pm.
536 The line will be closed on Saturday and Sunday however patient participants will receive an out of office

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537 message if they text in; the messages notes, Thank you for reaching out, we will get back to you when
538 we get back in the office! and a Patient Inquiry Incident is created. An exception to confidentiality is if
539 significant suicidal ideation, is exhibited through text message or via PHQ-9. Question 9 asks about
540 thoughts of being better off dead or of hurting oneself in some way over the last two weeks with an
541 associated scale delineating not at all, several days, more than half the days, or nearly every day. Those
542 indicating any response beyond not at all will be triaged to immediate access to a therapist via the
543 Cobalt platform. This is the current standard of care and will be the same for both Cobalt and Cobalt
544 plus in this trial.

545 *10.1 Subject Privacy*

546 Privacy refers to the person's desire to control access of others to themselves. Privacy concerns people,
547 whereas confidentiality concerns data. Describe the strategies to protect privacy giving consideration to
548 the following: The degree to which privacy can be expected in the proposed research and the safeguards
549 that will be put into place to respect those boundaries. The methods used to identify and contact
550 potential participants. The settings in which an individual will be interacting with an investigator. The
551 privacy guidelines developed by relevant professions, professional associations and scholarly disciplines
552 (e.g., psychiatry, genetic counseling, oral history, anthropology, psychology). Interview audio-recordings
553 will be transcribed verbatim and all identifiers will be removed. The recording and transcript will be kept
554 a secure and locked area with access limited to designated researchers. After we analyze the recordings,
555 we will destroy recordings after data analysis or completion of the study. All encounters will take place
556 online via BlueJeans or Way to Health, HIPAA compliant platform.

557 *10.2 Data Disclosure*

558 Survey data will be submitted to the National Institute of Mental Health Data Archive (NDA) at the
559 National Institutes of Health (NIH). NDA is a large database where deidentified study data from many
560 NIH studies are stored and managed. De-identified study data means that all personal information (such
561 as name, address, birthdate and phone number) is removed and replaced with a code number. PHI will
562 not be shared with anyone outside the parameters of the study as detailed in the Consent/HIPAA
563 process.

564 *10.3 Data confidentiality*

565 The following methods will be employed to protect patient PHI for this research study:

566 x Computer-based files will only be made available to personnel involved in the study through the use of
567 access privileges and passwords.

568 x Prior to access to any study-related information, personnel will be required to sign statements
569 agreeing to protect the security and confidentiality of identifiable information.

570 x Wherever feasible, identifiers will be removed from study-related information.

571 x A Certificate of Confidentiality will be obtained, because the research could place the subject at risk of
572 criminal or civil liability or cause damage to the subject's financial standing, employability, or liability.

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573 x Precautions are in place to ensure the data is secure by using passwords and encryption, because the
574 research involves web-based surveys.

575 x Audio and/or video recordings will be transcribed and then destroyed to eliminate audible
576 identification of subjects.

577 **11 Consent Process Overview**

578 Participants will enroll in this study via a remote recruitment process. The study coordinator will review
579 the consent script, which will include a description of the voluntary nature of participation, the study
580 procedures, risks and potential benefits in detail. Participants will be told that all information will be
581 kept strictly confidential, except as required by law. Subjects will be provided a copy of the consent
582 document. All efforts will be made by study staff to ensure subject privacy. Enrollment will be conducted
583 by the study coordinators who will enter patient information directly into the Way to Health platform
584 once a participant has consented to participate.

585 **11.2 Potential Study Risks**

586 Given that the study compares the same process delivered as either a pull (usual care = Cobalt) or a
587 push (intervention = Cobalt +) we believe risk is low. Nevertheless, we will engage a 3-member
588 independent Data and Safety Monitoring Board to oversee the trial. In accordance with conventional
589 practices, we will not identify members in advance so as not to disqualify potential proposal reviewers.
590 All subjects will be consented for participation and will have the ability to withdraw at any time. There is
591 minimal risk to the participants as Penn Cobalt will triage patients accordingly to level of services for
592 mental health support. All qualitative results will be de-identified and any collected PHI data will be
593 stored securely and separately. Participants can elect to not participate in the study without any
594 consequences. Participants can also opt-out of participating at any time. All employees have access to
595 Cobalt and associated services; participants in the intervention arm may be less likely to experience risks
596 associated with the research because they are receiving pushed services designed to reduce barriers to
597 access of mental health services..

598 **11.3 Potential Study Benefits**

599 All participants will have access to Cobalt, digital mental health and well-being platform which provides
600 stepped care based on needs. Additionally, participants using either Cobalt or Cobalt+ may identify
601 depression or anxiety otherwise unknown to them and then will be connected to care. The direct
602 benefit to human subjects is in the use of Cobalt (usual care) and for those who are in the Cobalt+
603 intervention arm, access to a pushed model of care where resources are opt-out. The information
604 learned from this study will hopefully help contribute to the fields of digital health and mental health.
605 The risks are reasonable in relation to the importance of knowledge expected to be gained. Information
606 learned from this study could improve our understanding of how digital platforms can be used to
607 engage participants, measure mental health using validated scales, and connection individuals to
608 resources and care. We will also gain insights about how these platforms impact access to care and
609 perceived barriers to care in healthcare workers. Ultimately, the data can be used to better understand
610 and improve strategies for protecting and supporting the mental health of healthcare workers
611 throughout the COVID-19 pandemic and its associated phases, but also in the future.

612 *11.4 Alternatives to Participation*

613 Not participate in the study. As a reminder, all Penn Medicine and University of Pennsylvania have
614 access to Cobalt resources, regardless of their participation in the study.

615 *11.5 Data and Safety Monitoring*
616

617 The study will be single-blinded and the study biostatistician will determine when to unblind the study.
618 Given that the study compares the same process delivered as either a pull (usual care = Cobalt) or a
619 push (intervention = Cobalt +) we believe risk is low. Nevertheless we will engage a 3-member
620 independent Data and Safety Monitoring Board to oversee the trial. In accordance with conventional
621 practices, we will not identify members in advance so as not to disqualify potential proposal reviewers.
622 Given that the study compares the same process delivered as either a pull (usual care) or a push
623 (intervention = well-being platform) we believe risk is low. Nevertheless, we will engage a 3-member
624 independent Data and Safety Monitoring Board to oversee the trial. In accordance with conventional
625 practices, we will not identify members in advance so as not to disqualify potential proposal reviewers.
626 These three external investigators will have expertise in mental health and wellness, employee health,
627 and digital health. In accordance with conventional practices, we will not identify members in advance
628 so as not to disqualify potential proposal reviewers. The responsibilities of the DSMB will include:
629 Reviewing the research protocol, consent, and plans for DSMB Evaluate the progress of the trial:
630 recruitment, retention, data quality, and adverse events Protection of participant safety Ensure high
631 standards for privacy and no breach of data security Provide written summary reports to the PI
632 (Merchant) and investigators after convening Provide a written summary report to the NIH funding body
633 if required This study will not have pre-specified stopping rules. The study will be single-blinded and the
634 study biostatistician will determine when to unblind the study..

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687 **1. Abstract**

688 Early in the pandemic, our team developed and implemented Penn Cobalt across the University of
689 Pennsylvania Health System which spans six acute-care hospitals and employs over 43,000 individuals.
690 Cobalt is a web-based platform that curates mental health and wellness content and provides
691 connection to group and individual support. Using validated mental health assessments, Cobalt triages
692 users to the right level and type of support across three categories: In the studio synchronous group
693 sessions, On your time asynchronous content, and 1:1 support. The 1:1 support represents a stepped
694 care model of mental health services and includes peer support, resilience coaches offering
695 psychological first aid, psychotherapists and psychiatrists. Cobalts embedded scheduling and telehealth
696 capabilities also provide HIPAA-compliant mental health care in a convenient, patient-centered model.
697 Cobalt content continuously adapts and evolves through crowdsourced feedback to encompass locally
698 defined and sensitive resources (e.g. addressing racial trauma). Over the first 7 months, Cobalt has had
699 over 140,000-page views and 18,300 unique users engaging with its content and support. The platform
700 identified 111 HCWs reporting thoughts of self-harm and connected those individuals with a mental
701 health provider for support and evaluation within 24 hours.

702
703 **2. Background**

704 Epidemics are often associated with significant mental health consequences to society. Large-scale
705 disasters, whether traumatic (e.g., the World Trade Center attacks or mass shootings), natural (e.g.,
706 hurricanes), or environmental (e.g., Deepwater Horizon oil spill), are often accompanied by increases in
707 depression, posttraumatic stress disorder (PTSD), substance use disorder, and a broad range of other
708 mental health and behavioral disorders, domestic violence, and child abuse. For example, prior work
709 showed that 5% of the population affected by Hurricane Ike in 2008 met the criteria for major
710 depressive disorder in the month after the hurricane; 1 out of 10 adults in New York City showed signs
711 of the disorder in the month following the 9/11 attacks. And almost 25% of New Yorkers reported
712 increased alcohol use after the tragic attacks. Communities affected by the Deepwater Horizon oil spill
713 showed signs of clinically significant depression and anxiety. The SARS epidemic was also associated with
714 increases in PTSD, stress, and psychological distress in patients and clinicians. For such events, the
715 impact on mental health can occur in the immediate aftermath and then persist over long time periods.
716 The rates of stress and burnout were high in health care workers prior to the pandemic and those rates
717 have persisted or increased. In March of 2020, COVID-19 emerged as a global pandemic resulting in
718 acute stressors directly impacting an already vulnerable and strained health care system. Healthcare
719 workers (HCWs) are facing unique challenges during the COVID-19 pandemic related to rapid shifts in
720 care, strains on availability of personal protective equipment, moral injury, and concerns about risks of
721 infection. The challenges confronting HCWs continue outside of work including childcare responsibilities,
722 career trajectory and concern for employment status with dynamically shifting practice models and
723 patient volumes. The mental health burdens of frontline HCWs began to emerge in early retrospective
724 studies from China and Italy; with early reports of increases in clinician suicide due to the pandemic.
725 HCWs are predicted to face repeated acute triggering events throughout the long period of
726 disillusionment we now find ourselves in as we slowly inch towards reconstruction and recovery with
727 the COVID-19 pandemic. Additional HCW stress is associated with the real or perceived risk of
728 contracting COVID-19 or spreading it to loved ones. A 2020 MMWR report on occupation type and job
729 setting of HCWs with COVID-19 showed that the relative percentage of cases was high in nurses (1742,
730 29.5%), environmental services (EVS) (330, 5.6%), physicians (190,3.2), and respiratory therapists (44,
731 0.7%). COVID-19 has also affected HCWs across demographics with higher rates of death in
732 underrepresented minorities. Among HCW with COVID-19 the median age was 41 years and 79% were
733 females. For the 69,678 (69%) of cases with available data on race and ethnicity the distribution was
734 Whites (47%), Blacks (26%), Hispanics (12%) Asians (9%). Compared with COVID-19 survivors, non-

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735 survivors were more likely to be older (median age 62), male (38% vs. 22%), Asian (20% vs. 9%), or Black
736 (32% versus 25%). The increased exposure to COVID-19 may also limit physical contact of HCW with
737 usual support networks and systems (e.g. family or faith-based groups) or lead to increased stress
738 because of home based caregiving for elderly or immunocompromised family members. HCWs
739 identifying as Black, indigenous, or of color are a vulnerable population. Prior reports support that black
740 adults are approximately 10% more likely to report psychological distress when compared with white
741 adults. Data from the Health and Human Services Office of Minority Health also shows that black adults
742 are more likely than white adults to report hopelessness, sadness, and feeling like everything is an
743 effort. There are significant barriers to accessing mental health care for black adults and it is estimated
744 that only one in three black adults who need mental health care receive it. Many reasons contribute to
745 these disparities including: costs of care, stigma associated with care, provider bias, lack of knowledge
746 regarding available mental health therapies, and the lack of minority mental health professionals. For
747 those who do receive care, the care is often of lower quality and not culturally aligned. Black HCWs have
748 historically been subject to racism, discrimination, and inequity--and the national events centered
749 around racial injustice coupled with COVID-19 have likely exacerbated mental health and well-being in
750 measurable and sustained ways. Minority HCWs were already strained, often working within settings
751 where they themselves are subject to microaggressions, overt acts of racism, structural racism and are
752 direct observers of racial inequities in patient care leading to significant disparities in morbidity and
753 mortality. Racial minorities are also disproportionately in jobs with high exposure risk including grocery
754 stores, public transportation, factories, and health care facilities. A meta-analysis of 293 studies
755 identified that racism significantly contributed to worse mental and physical health. Based on findings
756 from more than 60 structured interviews with Black HCWs, the noted sociologist Adia Wingfield
757 summarized her findings and noted: being a Black health care worker comes with specific difficulties
758 that can easily go unnoticed. In a pandemic where Black populations are among the hardest hit, these
759 difficulties are likely being magnified exponentially. Health care systems are undoubtedly taxed, but in
760 the interest of their workers, they should consider ways they can support Black health care providers to
761 offset the kinds of burnout and stresses research indicates they are likely experiencing right now. In this
762 national emergency, health care systems may need to think past providing health care just for patients
763 and consider the health of their workers, perhaps through counseling and support groups, heeding
764 employees suggestions for how systems can be improved. The social and economic consequences of
765 COVID-19 are predicted to affect women differently than men. Prior reports support that women have
766 been more likely to lose their jobs or leave them during the pandemic due to a need to provide child and
767 elder care as well as to support home schooling. While this unpaid labor has increased, paid work
768 opportunities have also decreased for women. Increases in sexual and physical violence toward women
769 during lockdowns have also been reported. The United Nations has identified increased vulnerability of
770 female frontline workers and the need for targeted programs to specifically address their unique mental
771 health needs due to a multitude of stressors. Prior reports have also focused on female frontline
772 providers and physician researchers and threats to their professional careers, particularly academic,
773 advancement due to barriers in work productivity as a result of COVID-19. The psychological impact of
774 the delay in academic career progression (e.g. fewer grant submissions, fewer peer-reviewed
775 publications, fewer leadership opportunities) could be pronounced and long standing. Considering how
776 the pandemic has led to considerable strain on women and the unique impact on women in health care,
777 this proposal specifically focuses on evaluating if Cobalt+ will have a greater impact on women and can
778 serve as a platform for addressing inequities in mental health care for this vulnerable population.
779 COVID-19 has increased the use and application of digital technologies in health care including text
780 messaging, mobile surveys, and telemedicine. Evolving and rapidly adopted approaches in mobile
781 engagement through digital technology create scalable opportunities to assess individuals needs in real-
782 time and can be used to rapidly deploy tailored well-being and mental health interventions. This

783 approach also offers a strategy to reveal the central tendencies, distributions, and associations which, in
784 population-based studies, can immediately inform a health systems approach toward maintaining a
785 healthy workforce and lowering barriers to mental health care.

786 **3. Overall Objectives**

787 Through a RCT, evaluate the effectiveness of Cobalt+ on HCW depression/anxiety (primary outcome)
788 compared with Cobalt (usual care). *Aims*

789 *3.1 Primary Aims*

790 Aim 1: Through a RCT, evaluate the effectiveness of Cobalt+ on HCW depression/anxiety (primary
791 outcome) compared with Cobalt (usual care).

792 Aim 2: To better understand perceptions of access to mental health care and the effectiveness of
793 Cobalt compared with Cobalt+ among HCWs through semi-structured qualitative interviews.

794 *3.2 Secondary Aims*

795 Secondary outcomes will include well-being, satisfaction with access to care, and measures of work
796 productivity. HTE will be explored for race and gender.

797

798 **4. Primary Outcome Variable**

799 Measures were selected based on clinical relevance, validity in the HCW population, and meaningfulness to
800 the target population. To facilitate data sharing, measures below were also identified to align with the NIMH
801 data archive when possible. The primary outcome will be depression and anxiety as measured by the Patient
802 Health Questionnaire (PHQ-9) and General Anxiety Disorder (GAD-7) respectively. PHQ-9 and GAD-7 have
803 been validated and used in multiple studies and provide easy, simple scales to quickly assess for depression
804 and anxiety. PHQ-9 is a 9-item score which ranges from 0 (least depressed) to 27 (most depressed). GAD-7 is a
805 7-item scale which assesses the frequency of anxiety symptoms over the past two weeks on a 4-point Likert-
806 scale ranging from 0 (never) to 3 (nearly every day). The total score of GAD-7 ranged from 0 to 21, with
807 increasing scores indicating more severe functional impairments as a result of anxiety.

808

809 **5. Secondary Outcome Variable(s)**

810 Well-being index: The Well-being index (WBI) is a nine-question survey validated for use in HCW populations
811 and considered important to health systems in managing the well-being of their workforce.

812 The World Health Organization- Five Well-Being Index (WHO-5) is a short self-reported measure of current
813 mental wellbeing. The WHO-5 has been found to have adequate validity in screening for depression and in
814 measuring outcomes in clinical trials. Item response theory analyses in studies of younger persons and
815 elderly persons indicate that the measure has good construct validity as a unidimensional scale measuring
816 well-being in these populations (Winther Topp et al., 2015).

817 Work productivity: To evaluate work productivity, we will use the Lam Employment Absence and
818 Productivity Scale, or LEAPS. It is a 10-item, self-rated scale that takes only 3 to 5 minutes for the patient to
819 complete. It is simple and easy to use. The items were chosen based on the symptoms that have the most
820 impact on work productivity and the most common productivity problems experienced by patients with
821 depression. The LEAPS was recently validated in a sample of 234 consecutive working patients meeting
822 DSM-IV criteria for MDD attending a mood disorders outpatient clinic (Lam et al, 2009).

823 Satisfaction with care: To assess satisfaction we used the Satisfaction Index- Mental Health (SIMH)(Nabati,
824 Shea, McBride, Gavin, & Bauer, 1998). The SIMH is a 12-item, self-report instrument developed to measure
825 patient satisfaction with mental health care (Nabati, et al., 1998). The SIMH has high internal consistency
826 reliability (Cronbachs alpha = 0.90), test- retest reliability (r = 0.79, p = 0.05), and sensitivity to change
827 (Nabati, et al., 1998).

828 Perceived System usability: System Usability Scale (SUS) provides a quick and dirty, reliable tool for
829 measuring the usability. It consists of a 10-item questionnaire with five response options for respondents;
830 from Strongly agree to Strongly disagree. Originally created by John Brooke in 1986, it allows you to evaluate

831 a wide variety of products and services, including hardware, software, mobile devices, websites and
832 applications. As required by the NIMH, WHODAS and DSM-5 Level 1 Cross-Cutting Symptom Measure are
833 asked only at the month 9 follow-up survey. These questions are voluntary to complete. WHODAS is a 12-
834 item questionnaire asks about difficulties due to health conditions. Health conditions include diseases or
835 illnesses, other health problems that may be short or long lasting, injuries, mental or emotional problems,
836 and problems with alcohol or drugs. Think back over the past 30 days and answer these questions, thinking
837 about how much difficulty you had doing the following activities. For each question, please circle only one
838 response. DOI: 10.2340/16501977-2583 The DSM-5 Level 1 Cross-Cutting Symptom Measure is a self- or
839 informant-rated measure that assesses mental health domains that are important across psychiatric
840 diagnoses. It is intended to help clinicians identify additional areas of inquiry that may have significant
841 impact on the individuals treatment and prognosis. In addition, the measure may be used to track changes
842 in the individuals symptom presentation over time. This version asks adults to consider how much (or how
843 often) they have been bothered by specific problems in the past two weeks. [https://](https://doi.org/10.1176/appi.books.9780890425596)
844 doi.org/10.1176/appi.books.9780890425596 DSM-5 includes sensitive questions around as suicide ideation,
845 mental health disorders including depression, anxiety, psychosis, dissociation and personality functioning,
846 and tobacco, alcohol, and substance use.

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6. Study Design

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6.1 Phase

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Not applicable

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6.2 Design

852

We will conduct a prospective two-armed randomized control trial to test the effect of tailored mental
853 health support on self-reported HCW mental health (anxiety and depression) during the response and
854 recovery phases of the COVID-19 pandemic. The control group will have access to Cobalt which is usual
855 care for all Penn Medicine employees. The Cobalt platform is web-based and is accessible from any
856 device or desktop. Cobalt uses contextual surveys and evidence-based assessments to triage individual
857 users to curated content and appropriate group or individual support. The current, and usual care,
858 model is a digital version of what exists at other institutions where resources are available for staff to
859 access wellness and mental health services. The usual care Cobalt model requires staff to personally
860 initiate multiple steps: 1) identify a personal need for support, 2) know where to seek support and care,
861 3) schedule an appointment, and 4) attend the appointment. In this context, the individual has to pull
862 the resources they need and there may be several barriers to completing each step. This is particularly
863 relevant as mental health conditions can compromise insight, motivation, and decision making, thereby
864 making self-directed engagement in care (pull) more challenging. The study will be single-blinded and
865 the study biostatistician will determine when to unblind the study. Given that the study compares the
866 same process delivered as either a pull (usual care = Cobalt) or a push (intervention = Cobalt +) we
867 believe risk is low. Nevertheless, we will engage a 3-member independent Data and Safety Monitoring
868 Board to oversee the trial. In accordance with conventional practices, we will not identify members in
869 advance so as not to disqualify potential proposal reviewers. To assess factors that may contribute
870 toward accessing and using mental health resources between Cobalt versus Cobalt+, we will conduct
871 semi-structured interviews (telephone or virtual video conference) with HCWs enrolled in Aim 1.
872 Standardized interview guides will be created using the consolidated framework for implementation
873 research (https://cfirguide.org/guide/app/#/guide_select) and thematic areas identified in literature
874 review to ensure uniformity in how and what questions are asked of each group. Some questions within
875 the guides will be the same between those in the traditional care arm (Cobalt) versus intervention
876 (Cobalt+) to allow for comparison. We will interview up to 80 HCWs from Penn Medicine in order to
877 understand the attitudes and decision-making involved in mental health strain during COVID-19. We will
878 recruit across both arms of the Aim 1 study to investigate HCW in usual care Cobalt (n= up to 40) and

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879 from those in the intervention arm Cobalt+ (n=up to 40). Using data from Aim 1, we will use a deviance
880 sampling approach to identify HCW from the top and bottom 25% percentiles of anxiety and depression
881 scales from month 6 to baseline. This deviant selection is intentional to maximize the potential to
882 identify themes unique to high or low levels of mental health strain. Individual scale scoring will not be
883 revealed in order to limit responder bias, increase response rates and avoid attribution bias. We intend
884 Aim 2 study sample to be similar to the Aim 1 gender and race breakdown. Since we oversampled Black
885 participants in Aim 1, we intend to have at least 25% Black participants in Aim 2. We will recruit HCWs
886 using a series of e-mails (up to 4 email invitations) and text messages (up to 3 text invitations). We will
887 contact participants to obtain consent, ensure study procedures are described, answer questions and
888 offer a \$50 gift card for their time. The goal is to conduct up to 80 audio-recorded semi-structured
889 interviews (~20-30 minutes). Interview questions will be aligned with themes from our preliminary
890 studies and focus groups with front line healthcare workers early in the pandemic. Participants will be
891 contacted one month following the end of the Aim 1 study period and consented via WTH. Participants
892 will not be informed as to why they were selected and confidentiality will be maintained. There is
893 variability in how individuals experience anxiety, depression, stress and overall well-being.
894 Understanding how HCWs think about these emotions, their physical and mental states of being, and
895 the decisions to access and utilize mental health resources are essential to the design of interventions to
896 facilitate and support the workforce. Understanding how HCWs approach mental health assessments for
897 themselves and the stigma associated with care is also critical in designing programs that are acceptable
898 and used. Investigation of the factors that impact mental health care in HCWs can be supported by semi-
899 structured interviews which ask open-ended questions and allow participants to describe key attitudes,
900 decision-making processes, and emotions that are otherwise difficult to assess. All Aim 2 participants
901 will be informed that, You do not have to participate in any research study offered by your director,
902 supervisor, or co-worker. If you choose not to participate, there will be no loss of benefits to which you
903 are otherwise entitled. Your employment is not in jeopardy should you decide not to participate If you
904 are interested in participating, A research team member is readily available to discuss the informed
905 consent form with you and answer questions via email or telephone communications. You are free to
906 decline or stop participation at any time during or after the initial consenting process. Please text back
907 the Way to Health number or email digitalhealth@uphs.upenn.edu. The University of Pennsylvania has a
908 significant financial interest in the Penn Medicine COBALT resources and delivery system used as a part
909 of this protocol. It was developed by inventors at Penn Medicine, and if it were to be successful, the
910 University of Pennsylvania will likely receive significant financial benefit. As a reminder, all Penn
911 Medicine employees have access to COBALT for resources regardless of if they participate in the study.
912 You are free to decline or stop participation at any time during or after the initial consenting process. To
913 decline or stop participation, please email digitalhealth@uphs.upenn.edu or text in Bye to the Way to
914 Health number. If Aim 2 participants expresses potentially sensitive information like mental health
915 information, at the end of the interview, we will share free and confidential health resources.

916 *6.3 Study Duration*

917 The RCT will compare this pull model with a new model, the intervention named Cobalt+, which will
918 proactively reach out to and engage individuals in order to reduce barriers in identifying a need for and
919 accessing mental health care. The intervention group will have access to the same Cobalt resources as
920 those in the usual care group but will also receive a comprehensive suite of services including: 1)
921 monthly automated text messaging reminders and links to Cobalt resources 2) intermittent mental
922 health assessments (PHQ-9, GAD-7) at enrollment, month 2, month 4 and month 6 which triage
923 individuals to an opt-out appointment with a resilience coach, psychotherapist, or psychiatrist based on
924 their results. Of note, all employees will have access to Cobalt whether they are in the study or not.
925 Through the proposed RCT we will evaluate whether the intervention, a proactive model of care delivery
926 (Cobalt+) impacts the primary outcome measure (depression and anxiety) and secondary outcome

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927 measures (well-being, satisfaction with access to care, and measures of work productivity [e.g.
928 absenteeism]). The study duration is approximately 29 months.

929 *6.4 Facilities*

930 The research team is highly experienced and well-positioned to execute this project rapidly and across
931 departments and hospitals within Penn Medicine. Team members have worked closely on many clinical
932 and research programs, conducted clinical trials using mobile and digital tools and platforms, and
933 conducted trials specifically in the target vulnerable population, HCW. Pilot work from this team has led
934 to multiple peer-reviewed publications in wellbeing, mental health, and deploying digital tools and
935 platforms. We have enthusiastic support from Penn Medicine and departmental leadership in
936 developing strategies to identify, support, and protect HCW well-being and mental health. Our team is
937 interwoven within the frontline clinical workforce. The research team brings together expertise in real-
938 time patient- centered engagement using digital tools (Merchant, Agarwal, Asch), digital health
939 (Merchant, Agarwal), well-being research (Bellini, Asch, Agarwal, Wolk), survey and qualitative methods
940 (Shea), advanced biostatistics and computational methods (Mitra) and innovations in health systems
941 (Asch, Merchant, Agarwal). Our team also has integral roles in Penn Medicine leadership which can help
942 with project stewardship and uptake: PI (Merchant) serves as the Penn Medicine Associate Vice
943 President of Digital Health, Co-I (Bellini) is the Senior Vice Dean for Academic Affairs and health system
944 lead for Cobalt, and Co-I (Asch) is the Executive Director of the Penn Medicine Center for Health Care
945 Innovation and Innovation lead for Cobalt. Additionally, Penn is an opportune venue to conduct COVID-
946 19 related research as a leader in the region in acute and virtual care during the pandemic. This proposal
947 represents a natural next step to build upon our expertise and track record of success in designing,
948 conducting, and disseminating meaningful and actionable patient and provider centered research.
949 Advisory Board and stakeholder engagement: To insure input from providers that will inform the
950 research, we will convene an advisory board representing entities from each (n=12) of the direct patient
951 care groups (e.g. physicians, nurses, certified nursing assistants, lab technicians, radiology technicians
952 physical therapists, occupational therapists, pharmacists, pharmacy technicians, patient registration
953 staff, patient intake coordinators, environmental service personnel). We have strong existing
954 relationships with these groups and will meet with them before the study initiates and then every 6
955 months thereafter for input, engagement, and feedback. Some of the members of this group will also be
956 recruitment champions identified. This step is critically important and we will work collaboratively with
957 this group for stakeholder guidance about all aspects of execution and reporting for the study.

958 *6.5 Key Inclusion Criteria*

959 There are no inclusion and exclusion criteria for any subpopulation based on race/ethnicity, age, gender,
960 status as a vulnerable population. Eligibility criteria for study enrollment will include: 1) age 18 years or
961 older; 2) regular, daily access to a smartphone 3) able to communicate fluently in English (as the current
962 Cobalt assessments and resources are in English at this time), 4) work at least 4 hours per week in either
963 a hospital or outpatient based settings (e.g. physicians, nurses, certified nursing assistants, lab
964 technicians, radiology technicians, physical therapist, occupational therapist, pharmacists, pharmacy
965 technicians, patient registration staff, receptionists/patient intake coordinators, environmental service
966 personnel) approximately 4 hours/week (on average 192 hours/ 48 weeks in a year) in the study time
967 frame. Eligible participants will then have an opportunity to consent to study participation. Any HCW
968 meeting these criteria will be eligible to participate in the research; we will not exclude any potential
969 participant based on a priori criteria.

970 *6.6 Key Exclusion Criteria*

971 1). Under 18 years of age; 2) does not have regular, daily access to a smartphone 3) unable to
972 communicate fluently in English (as the current Cobalt assessments and resources are in English at this
973

974 time), 4) does not not work at least 4 hours per week in either a hospital or outpatient based setting, 5).
975 Not willing to sign the informed consent document.

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977 **7. Subject Recruitment**

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978 *7.1 Target Population*

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The population of interest for this proposal is HCWs who in the midst of COVID-19 are at increased risk for mental health symptoms and conditions. We will also utilize University groups and motivated mental healthcare champions to specifically promote inclusion of female and underrepresented minority HCW in the RCT and qualitative aim. This focus aligns with the RFA which identifies vulnerable populations as: medical personnel with direct patient care and NIH-designated health disparity racial/ ethnic minorities. We specifically include a broad definition of HCWs (e.g. physicians, nurses, certified nursing assistants, lab technicians, radiology technicians, physical therapists, occupational therapists, pharmacists, pharmacy technicians, patient registration staff, coroners, receptionists/patient intake coordinators, environmental service personnel) that are not routinely evaluated jointly and with the same intervention. While much of the attention in the pandemic has been on physicians and nurses we aim to focus on a broader group that is at risk for COVID-19 and mental health symptoms and conditions. our study samples demographic information, specifically gender, race, and ethnicity compared to the larger employee group. We will receive de-identified proportions of this information from University of Pennsylvania administration. Demographic information will include: % female, % male, % non-reported/missing, % American Indian/Alaskan Native, % Asian, % Black or African American, % Native Hawaiian/Pacific Islander, % White, % I do not wish to answer, % non-reported/ missing, % Hispanic / Latinx, and % non-reported/missing. The demographic information would be used for internal discussions only with the Penn Medicine research personnel listed on our IRB HSERA protocol (IRB #: 848844).

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998 *7.2 Subjects at Penn 1,275*

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999 *7.3 Accrual*

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To recruit potential study participants, we will send an email about the study to the entire Penn Medicine employee listserv, as these individuals are the same recipients of Penn Medicine news and Covid-19 updates who have received prior information about the availability of Cobalt. Emails will be sent up to 5 times to this employee list. The plan to outreach to employees in this manner has been approved by both Penn Medicine Human Resources and the Penn Medicine Chief Operation Officer. We will specifically engage recruitment champions in the study design and for support in extending the reach of the recruitment email to underrepresented minority HCWs. These recruitment champions will include each Departments Vice Chair for Diversity and Inclusion to support sending the email about the study to their Departments and groups within their Departments specifically focused on diversity and inclusion. We will also engage Centers, Departments, and Groups at Penn Medicine to support dissemination of the study announcement. These include the Office of Inclusion and Diversity, the Alliance of Minority Physicians, Penn Medicine Center for Health Equity Advancement, Bold Solutions Initiative, FOCUS on health and leadership for women, Penn Promotes research on sex and gender in health, and the Program for Health Equity in Education and Research. Furthermore, we will recruit in-person across the Penn Medicine campus such as tabling outside of prominent buildings and departments (New Pavilion and cafeterias) and attend department morning huddles / meetings to accommodate staff members who have limited access to their email accounts. We will also be intentional about diversity of representation in the images in all study materials and highlight the diversity in our project team. We base our power considerations on baseline data presented in an RCT conducted by Graham et al.⁹² In their study, they report a mean baseline PHQ-9 of 14.0 (SE=5.0) and mean GAD-7 of 11.6 (SE=4.6). We assume a type I error rate of 2.5% (.05/2) to account for the two

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1021 separate outcomes that we will be evaluating. We aim to enroll 1275 participants with the anticipation
1022 that there will be 27.5% attrition.

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1024 *7.4 Patient Subject Recruitment*

1025 To recruit potential study participants, we will send an email about the study to the entire Penn
1026 Medicine employee listserv, as these individuals are the same recipients of Penn Medicine news and
1027 Covid-19 updates who have received prior information about the availability of Cobalt. Emails will be
1028 sent up to 5 times to this employee list. The plan to outreach to employees in this manner has been
1029 approved by both Penn Medicine Human Resources and the Penn Medicine Chief Operation Officer (see
1030 letters of support). Exploratory Aim1 specifically seeks to determine if the effect of the intervention
1031 varies across patient subgroups (e.g. race and gender) as we recognize the importance of evaluating the
1032 effect of Cobalt in these specific populations. We will specifically engage recruitment champions in the
1033 study design and for support in extending the reach of the recruitment email to underrepresented
1034 minority HCWs. These recruitment champions will include each Departments Vice Chair for Diversity and
1035 Inclusion to support sending the email about the study to their Departments and groups within their
1036 Departments specifically focused on diversity and inclusion. We will also engage Centers, Departments,
1037 and Groups at Penn Medicine to support dissemination of the study announcement. These include the
1038 Office of Inclusion and Diversity, the Alliance of Minority Physicians, Penn Medicine Center for Health
1039 Equity Advancement, Bold Solutions Initiative, FOCUS on health and leadership for women, Penn
1040 Promotes research on sex and gender in health, and the Program for Health Equity in Education and
1041 Research. Furthermore, we will recruit in-person across the Penn Medicine campus such as tabling
1042 outside of prominent buildings and departments (New Pavilion and cafeterias) and attend department
1043 morning huddles / meetings to accommodate staff members who have limited access to their email
1044 accounts. We will also be intentional about diversity of representation in the images in all study
1045 materials and highlight the diversity in our project team. For enrolled study participants, there is no
1046 email or text message follow for nudge messages. However, there is one text message or email follow
1047 up message (based on the participants communication preference) to complete survey assessments. For
1048 example, the message notes: Hi PARTICIPANT_FIRSTNAME, when you have a chance, please complete
1049 this short well-being survey: It only takes about 2 minutes! Thanks for your reply! For 6 and 9 month
1050 follow up survey reminders, we will send the following text message or email, Hi
1051 PARTICIPANT_FIRSTNAME, please complete the last follow up survey by clicking here: Once you
1052 complete it, \$75 will be loaded on your ClinCard account. To promote retention, participants will be
1053 emailed up to 4 times and texted (up to three times) to nudge survey and assessment completion. For
1054 compensation, each participant will receive up to \$200: \$50 at enrollment, \$75 at 6 months and \$75 at 9
1055 months for 3 total surveys. Submission for subject reimbursement will occur immediately upon
1056 completion of surveys and assessments and occur through the Way to Health platform which facilitates
1057 timely payment. Using data from Aim 1, we will use a deviance sampling approach to identify HCW from
1058 the top and bottom 25% percentiles of anxiety and depression scales. This deviant selection is
1059 intentional to maximize the potential to identify themes unique to high or low levels of mental health
1060 strain. Individual scale scoring will not be revealed in order to limit responder bias, increase response
1061 rates and avoid attribution bias. We will recruit participants enrolled in Aim 1 (RCT), using a series of e-
1062 mails (up to 4 email invitations) and text messages (up to 3 text invitations). We will contact participants
1063 to obtain informed consent for the interview to ensure study procedures are described, answer
1064 questions and offer a \$50 gift card for their time. The goal is to conduct 80 audio-recorded semi-
1065 structured interviews (~20-30 minutes). Interview questions will be aligned with themes from our
1066 preliminary studies and focus groups with front line healthcare workers early in the pandemic.
1067 Participants will be contacted one month following the end of the Aim 1 study period and consented via

1068 Way to Health. Participants will not be informed as to why they were selected, and confidentiality will
1069 be maintained.

1070 *7.5 Subject Compensation*

1071 To promote retention, participants will be emailed up to 4 times and texted (up to three times) to nudge
1072 survey and assessment completion. For compensation, each participant will receive up to \$200: \$50 at
1073 enrollment, \$75 at 6 months and \$75 at 9 months for 3 total surveys. Submission for subject
1074 reimbursement will occur immediately upon completion of surveys and assessments and occur through
1075 the Way to Health platform which facilitates timely payment. Each participant will receive \$50 for
1076 interview completion.

1077 **8. Study Procedures**

1078 *8.1 Consent Process*

1079 To recruit potential study participants, we will send an email about the study to the entire Penn
1080 Medicine employee listserv, these individuals are the same recipients of Penn Medicine news and
1081 COVID-19 updates who have received prior information about the availability of Cobalt. Emails will be
1082 sent up to 4 times to this employee list. This proposal includes a letter of support from the Penn
1083 Medicine Director of Human Resources and Penn Medicine Chief Operation Officer indicating support
1084 for the project and access to these listservs. Participants will provide electronic informed consent before
1085 participation in the study. The electronic consent form is hosted on Way to Health, HIPAA Compliant
1086 Platform. Participants will be notified that enrollment is voluntary and declining to participate will not
1087 change their access to Cobalt or have an impact on their employment. Participants will be consented
1088 with ample time to discuss consent. Participants will be given contact information (including telephone
1089 and email) for the principal investigator (Dr. Merchant), and the University of Pennsylvania IRB to
1090 address any potential concerns. A detailed Manual of Operations will be developed for the study and
1091 procedures will be designed to ensure efficient and prompt updating. Our project is designed to function
1092 entirely remotely (recruitment, consent, enrollment, survey completion) All study participants read and
1093 review the informed consent document independently on Way to Health but research team members
1094 are readily available to discuss the form and answer questions via email or telephone communications,
1095 all noted on the instructions of the informed consent document on Way to Health. All investigators have
1096 experience in developing a manual of operations. All study staff will undergo a thorough training and
1097 certification procedure prior to protocol implementation, including CITI Course in the Protection of
1098 Human Research Participants online training in research ethics. The initial training will be conducted by
1099 the PI and will include an overview of the study, detailed explanation of the study protocol, and hands-
1100 on practice of specific protocol components. All study staff will be observed conducting randomly
1101 selected protocol duties at least twice annually and evaluated using specifically designed checklists.

1102 *8.1.1.1 Waiver or Alteration of Informed Consent*

1103 Not applicable

1104 *8.1.1.2 Minimal Risk*

1105 Since we are recruiting Penn Medicine employees, the informed consent highlights how their Penn
1106 Medicine employer, director, supervisor, or co-worker may be an investigator in this research study. The
1107 document also includes language on how if the individual chooses not to participate, there will be no
1108 loss of benefits to which they are otherwise entitled. Their employment is not in jeopardy based on their
1109 enrollment status. Given that the study compares the same process delivered as either a pull (usual care
1110 = Cobalt) or a push (intervention = Cobalt +) we believe risk is low. Nevertheless, we will engage a 3-
1111 member independent Data and Safety Monitoring Board to oversee the trial. In accordance with
1112 conventional practices, we will not identify members in advance so as not to disqualify potential
1113 proposal reviewers. All subjects will be consented for participation and will have the ability to withdraw
1114 at any time. There is minimal risk to the participants as Penn Cobalt will triage patients accordingly to
1115 level of services for mental health support. All qualitative results will be de-identified and any collected

1116 PHI data will be stored securely and separately. Participants can elect to not participate in the study
1117 without any consequences. Participants can also opt-out of participating at any time. All employees have
1118 access to Cobalt and associated services; participants in the intervention arm may be less likely to
1119 experience risks associated with the research because they are receiving pushed services designed to
1120 reduce barriers to access of mental health services.

1121 *8.1.1.3 Impact on Subject Rights and Welfare*

1122 We will be obtaining informed consent from patients who have been provided a thorough explanation
1123 of the study and the opportunity to ask any questions about study participation. Patients will be read
1124 the entire consent and given the option to participate.

1125 *8.1.1.4 Waiver Essential to Research*

1126 All participants will be recruited through remote procedures.

1127 *8.1.1.5 Written Statement of Research*

1128 This study does not operate under a written statement of research.

1129 *8.2 Procedures*

1130 We will conduct a prospective two-armed randomized control trial to test the effect of tailored mental
1131 health support on self-reported HCW mental health (anxiety and depression) during the response and
1132 recovery phases of the COVID-19 pandemic. The control group will have access to Cobalt which is usual
1133 care for all Penn Medicine employees. The Cobalt platform is web-based and is accessible from any
1134 device or desktop. Cobalt uses contextual surveys and evidence-based assessments to triage individual
1135 users to curated content and appropriate group or individual support. The current, and usual care,
1136 model is a digital version of what exists at other institutions where resources are available for staff to
1137 access wellness and mental health services. The usual care Cobalt model requires staff to personally
1138 initiate multiple steps: 1) identify a personal need for support, 2) know where to seek support and care,
1139 3) schedule an appointment, and 4) attend the appointment. In this context, the individual has to pull
1140 the resources they need and there may be several barriers to completing each step. This is particularly
1141 relevant as mental health conditions can compromise insight, motivation, and decision making, thereby
1142 making self-directed engagement in care (pull) more challenging. The RCT will compare this pull model
1143 with a new model, the intervention named Cobalt+, which will proactively reach out to and engage
1144 individuals in order to reduce barriers in identifying a need for and accessing mental health care. The
1145 intervention group will have access to the same Cobalt resources as those in the usual care group but
1146 will also receive a comprehensive suite of services including: 1) monthly automated text messaging
1147 reminders and links to Cobalt resources 2) intermittent mental health assessments (PHQ-9, GAD-7) at
1148 enrollment, month 2, month 4 and month 6 which triage individuals to an opt-out appointment with a
1149 resilience coach, psychotherapist, or psychiatrist based on their results. Of note, all employees will have
1150 access to Cobalt whether they are in the study or not. Through the proposed RCT we will evaluate
1151 whether the intervention, a proactive model of care delivery (Cobalt+) impacts the primary outcome
1152 measure (depression and anxiety) and secondary outcome measures (well-being, satisfaction with
1153 access to care, and measures of work productivity [e.g. absenteeism]). Difficulties due to health
1154 conditions mental health domains will be assessed at the month 9 follow up survey.

1155 **9. Analysis Plan**

1156 We will conduct an intent to treat (ITT) analysis. The ITT analysis will include all randomized participants
1157 in the groups to which they were randomly assigned. Baseline demographic and clinical characteristics
1158 will be reported as frequency and percent for categorical variables and median and distribution for
1159 continuous variables. We will compare baseline characteristics between intervention and control arms
1160 using t-tests for continuous variables and chi-squared tests for categorical variables. The goal of these
1161 comparisons will be to determine if the two arms are balanced on baseline variables after
1162 randomization. Our primary analysis will focus on the difference in PHQ-9 and GAD-7 scores at 6 months
1163 between the two arms. We will estimate and test differences in means between arms using two- sample

1164 t-tests and generalized linear models that account for baseline measurements of PHQ-9 and GAD-7.
1165 Missing data will be assessed for patterns and multiple imputation will be used if deemed appropriate.
1166 Baseline covariates that are found to be imbalanced between arms may be adjusted for in the model if
1167 they were deemed to be potential confounders a priori to adjust for potential confounding and for
1168 efficiency gain. We will use all available PHQ-9 and GAD-7 scores on eligible patients from randomization
1169 through the last observation. A $p < 0.05$ will be deemed statistically significant but emphasis will be placed
1170 on point estimates and confidence intervals. Secondary outcomes of mental healthcare utilization,
1171 satisfaction with connection to services, and qualitative feedback on mobile engagement will also be
1172 modeled using GEE with mean models specified based on the distribution of the specific outcome (e.g.
1173 Poisson or negative binomial for number of mental healthcare visits, logit for binary responses).
1174 Potential associations between system-level or regional level case burden and PHQ-9 and GAD-7 scores
1175 at baseline and over-time will be assessed with generalized linear models and GEE. Exploratory Aim 1:
1176 Statistical approach: The statistical approach for studying HTE will be to test for the statistical
1177 interaction between the intervention and race and separately by gender in the GEE models described
1178 above. Although our study was not designed specifically to detect HTE, if 20% of our trial participants
1179 are Black (based on targeted recruitment efforts), our study will achieve 80% power (assuming type I
1180 error of 0.05) to detect a 1.8 difference in mean GAD-7 scores and a 2.0 difference in mean PHQ-9
1181 scores between arms at 6 months. We anticipate that at least 50% of participants will be female. Hence,
1182 our study is powered to detect a 1.2 difference in mean GAD-7 scores and a 1.3 difference in mean PHQ-
1183 9 scores between arms at 6 months among women.
1184 Aim 2: Power: no power calculation will be performed for this qualitative aim consistent with prior
1185 qualitative aims we will aim to interview 80 participants from Aim 1 and evaluate themes until
1186 saturation Analysis: Using thematic analysis, we will analyze HCW interview transcripts to identify
1187 recurring themes in attitudes and beliefs toward mental health, well-being, and mental health care or
1188 resources. Interview audio will be transcribed and uploaded into Nvivo software (available as a Penn
1189 resource). In total we plan for up to 80 semi-structured interviews, or until inductive thematic
1190 saturation¹⁰¹ is reached in each group meaning no new themes are emerging. Analysis of qualitative,
1191 semi-structured interviews utilizes a series of systematic steps in transcribing, developing a code for
1192 thematic content, and subsequent coding of interviews. A modified grounded theory approach will be
1193 used to evaluate interview transcriptions. Analysis will begin shortly after the first few interviews are
1194 completed. An emergent, iterative open coding process will be followed and two trained coders from
1195 the research team will jointly read five transcripts and draft the outline of a codebook. Each coder will
1196 then independently code five more transcripts and adjust the codebook as needed. We will review the
1197 codes, resolve discrepancies and finalize coding procedures. Following adjudication of any areas of
1198 discrepancy, the research team coders will be assigned batches of transcripts for independent coding,
1199 sharing 25% of the transcripts in each batch for ongoing inter-rater agreement assessment. We will
1200 review coding for interrater reliability, measured by Cohens kappa (0.8), and overall comprehensiveness.
1201 If a high kappa is not achieved, further double coding and refining of the code will continue. This
1202 approach to coding and analyzing qualitative data has been widely used. Strategies used to ensure
1203 reliability and validity in the qualitative data will include a comprehensive audit trail, checks between
1204 coders, team debriefing, and corroboration of findings across participants.

1205 **10. Subject Confidentiality**

1206 The research team will exercise extreme caution with identifiable private information. Patients
1207 randomized to the intervention arm will receive text messages from Way to Health. In the patients
1208 informed consent, they are instructed and agree by signing the document that they will not disclose
1209 personal health information (PHI) on the Way to Health texting platform and only respond to the text

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1210 message prompts. When patient participants (both control and intervention) text into the Way to Health
1211 or complete a survey, the research team will receive email notification immediately. The research team
1212 is instructed to review the message within 1-4 hours of delivery, Monday through Friday, 8 am to 5pm.
1213 The line will be closed on Saturday and Sunday however patient participants will receive an out of office
1214 message if they text in; the messages notes, Thank you for reaching out, we will get back to you when
1215 we get back in the office! and a Patient Inquiry Incident is created. An exception to confidentiality is if
1216 significant suicidal ideation, is exhibited through text message or via PHQ-9 question 9 or 9 or DSM-5
1217 question 11. PHQ-9, Question 9 asks about thoughts of being better off dead or of hurting oneself in
1218 some way over the last two weeks with an associated scale delineating not at all, several days, more
1219 than half the days, or nearly every day. The DSM-5, question 11 asks about During the past TWO (2)
1220 WEEKS, how much (or how often) have you been bothered by the following problems? Thoughts of
1221 actually hurting yourself? with an associated scale delineating None: Not at all; Slight Rare, less than a
1222 day or two; Mild: Several days; Moderate: More than half the days; and Severe: Nearly every day. Those
1223 indicating any response beyond not at all or none not at all will be triaged to Penn Behavioral Health
1224 Corporate Services / EAP. This is the current standard of care and will be the same for both Cobalt and
1225 Cobalt plus in this trial. EAP will receive only the participants phone number via email. If EAP logs into
1226 Cobalt, a HIPAA compliant platform, they can view the studys participants phone number, first and last
1227 name and PHQ-9 score and PHQ-9 question 9 score. In case Penn Behavioral Health Corporate Services /
1228 EAP is unable to contact a study participant within the 72-hour period, a research team member will call
1229 the study participant and complete the Ask Suicide-Screening Questions (ASQ) and NIMH TOOLKIT:
1230 OUTPATIENT Brief Suicide Safety Assessment.

1231 *10.1 Subject Privacy*

1232 Aim 2 transcripts and audio files will be saved on a Penn Medicine managed, HIPAA compliant server.
1233 Interview audio-recordings will be transcribed verbatim and all identifiers will be removed. The
1234 recording and transcript will be kept a secure and locked area with access limited to designated
1235 researchers. After we analyze the recordings, we will destroy recordings after data analysis or
1236 completion of the study. All encounters will take place online via BlueJeans or Way to Health, HIPAA
1237 compliant platform. or Zoom videoconference. All encounters will take place in-person in a secure
1238 private room or online via Zoom (other Penn approved video conferencing platform) or Way to Health,
1239 HIPAA compliant platform. When utilizing Zoom for audio recordings, additional steps will be made by
1240 the research team to ensure participant safety. Based on guidelines, researchers will ensure the
1241 following settings for privacy and compliance for Penn Zoom. 1) Researchers will turn off the Personal
1242 Meeting ID setting and instead opt for the meeting ID to be generated automatically, allowing for new
1243 links and meeting IDs to be created for each meeting. 2) Research staff will turn off Cloud Recordings
1244 and ensure only local recordings that are HIPAA compliant are used as they are encrypted and managed
1245 by PMACS/DART or UPHS. Interview audio-recordings will be transcribed verbatim and all identifiers will
1246 be removed. The recording and transcript will be kept a secure and locked area with access limited to
1247 designated researchers. After we analyze the recordings, we will destroy recordings after data analysis
1248 or completion of the study. All survey data will be stored in a secure, web-based database (Way to
1249 Health or REDCap) where a study ID number will be generated for each patient. A link between the
1250 study ID number and the patient PHI will need to be maintained to ensure that the study staff can track
1251 recruitment efforts to potential participants and to avoid contacting any patients who have previously
1252 declined to participate. To ensure that patient confidentiality is preserved, individual identifiers (such as
1253 name) are stored in a single password protected system that is accessible to study research, analysis and
1254 IT staff only. This system is hosted on site at UPenn and is protected by a secure firewall. Once a
1255 participant is in this system, they will be given a unique study ID number. Any datasets and computer

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1256 files that leave the firewall will be stripped of all identifiers besides the study ID and individuals will be
1257 referred to by their study ID only. The study ID will also be used on all analytical files. Way to Health and
1258 REDCap are secure web applications for building and managing online surveys and databases. Privacy of
1259 all study data will be maintained by restricting access to the identifiable information only to approved
1260 study staff who have received subject confidentiality and privacy training. Study coordinators will access
1261 patient contact information from the database to conduct recruitment phone calls. The study
1262 coordinator will review the consent script, which will include a description of the voluntary nature of
1263 participation, the study procedures, risks and potential benefits in detail. Participants will be told that all
1264 information will be kept strictly confidential, except as required by law. Subjects will be provided a copy
1265 of the consent document. All efforts will be made by study staff to ensure subject privacy. Enrollment
1266 will be conducted by the study coordinators who will enter patient information directly into the Way to
1267 Health platform once a participant has consented to participate. This database is hosted on a secure
1268 server as detailed in the subject confidentiality section. Study coordinators may have to contact patients
1269 in the intervention and their support partners during the course of the study and will use the WTH
1270 database to access contact information to facilitate this contact. If suicidal ideation, is exhibited through
1271 text message or via PHQ-9 question 9 or DSM-5 Question 11. PHQ-9, Question 9 asks about thoughts of
1272 being better off dead or of hurting oneself in some way over the last two weeks with an associated scale
1273 delineating not at all, several days, more than half the days, or nearly every day. The DSM-5, question 11
1274 asks about During the past TWO (2) WEEKS, how much (or how often) have you been bothered by the
1275 following problems? Thoughts of actually hurting yourself? with an associated scale delineating None:
1276 Not at all; Slight Rare, less than a day or two; Mild: Several days; Moderate: More than half the days;
1277 and Severe: Nearly every day. Those indicating any response beyond not at all or none not at all will be
1278 triaged to Penn Behavioral Health Corporate Services / EAP. This is the current standard of care and will
1279 be the same for both Cobalt and Cobalt plus in this trial. In case Penn Behavioral Health Corporate
1280 Services / EAP is unable to contact a study participant within the 72-hour period, a research team
1281 member will call the study participant and complete the Ask Suicide-Screening Questions (ASQ) and
1282 NIMH TOOLKIT: OUTPATIENT Brief Suicide Safety Assessment. This will be explained to the participant in
1283 the consent process and when the details of study participation are explained by the coordinator. If a
1284 participant books an appointment at the TEAMS Clinic, the research team will receive data from their
1285 PennChart such as if appointments are fulfilled or cancelled/skipped. Survey data will be submitted to
1286 the National Institute of Mental Health Data Archive (NDA) at the National Institutes of Health (NIH).
1287 NDA is a large database where deidentified study data from many NIH studies are stored and managed.
1288 De- identified study data means that all personal information (such as name, address, birthdate and
1289 phone number) is removed and replaced with a code number. PHI will not be shared with anyone
1290 outside the parameters of the study as detailed in the Consent/HIPAA process.

1291 10.2 *Data Disclosure*

1292 Survey data will be submitted to the National Institute of Mental Health Data Archive (NDA) at the
1293 National Institutes of Health (NIH). NDA is a large database where deidentified study data from many
1294 NIH studies are stored and managed. De- identified study data means that all personal information (such
1295 as name, address, birthdate and phone number) is removed and replaced with a code number. PHI will
1296 not be shared with anyone outside the parameters of the study as detailed in the Consent/HIPAA
1297 process.

1298 10.3 *Data confidentiality*

1299 The following methods will be employed to protect patient PHI for this research study:

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1300 x Computer-based files will only be made available to personnel involved in the study through the use of
1301 access privileges and passwords.

1302 x Prior to access to any study-related information, personnel will be required to sign statements
1303 agreeing to protect the security and confidentiality of identifiable information.

1304 x Wherever feasible, identifiers will be removed from study-related information.

1305 x A Certificate of Confidentiality will be obtained, because the research could place the subject at risk of
1306 criminal or civil liability or cause damage to the subject's financial standing, employability, or liability.

1307 x Precautions are in place to ensure the data is secure by using passwords and encryption, because the
1308 research involves web-based surveys.

1309 x Audio and/or video recordings will be transcribed and then destroyed to eliminate audible
1310 identification of subjects.

1311 11. Consent Process Overview

1312 Participants will enroll in this study via a remote recruitment process. The study coordinator will review
1313 the consent script, which will include a description of the voluntary nature of participation, the study
1314 procedures, risks and potential benefits in detail. Participants will be told that all information will be
1315 kept strictly confidential, except as required by law. Subjects will be provided a copy of the consent
1316 document. All efforts will be made by study staff to ensure subject privacy. Enrollment will be conducted
1317 by the study coordinators who will enter patient information directly into the Way to Health platform
1318 once a participant has consented to participate.

1319 11.1 Potential Study Risks

1320 We are requesting a waiver of the requirement to document consent and HIPAA authorization with a
1321 signature for participants enrolled into this study since we believe that the research presents no more
1322 than minimal risk of harm to subjects and involves no procedures for which written consent is normally
1323 required outside of the research context. [45 CFR 46.117(c)(2)] Participants will enroll in this study via a
1324 remote recruitment process, and therefore, we will read the IRB-approved Consent/HIPAA script over
1325 the phone to each participant and ask them to provide verbal consent and verbal HIPAA authorization
1326 for use of their data in the study. After a patient provides verbal consent, the coordinator will select this
1327 option on the Consent/HIPAA screen on the participants' profile that was created during enrollment on
1328 the WTH platform for this study. A copy of the Consent/HIPAA document will be included in the device
1329 packet provided to them by mail to the patients' home address.

1330 11.2 Potential Study Benefits

1331 All participants will have access to Cobalt, digital mental health and well-being platform which provides
1332 stepped care based on needs. Additionally, participants using either Cobalt or Cobalt+ may identify
1333 depression or anxiety otherwise unknown to them and then will be connected to care. The direct
1334 benefit to human subjects is in the use of Cobalt (usual care) and for those who are in the Cobalt+
1335 intervention arm, access to a pushed model of care where resources are opt-out. The information

1336 learned from this study will hopefully help contribute to the fields of digital health and mental health.
1337 The risks are reasonable in relation to the importance of knowledge expected to be gained. Information
1338 learned from this study could improve our understanding of how digital platforms can be used to
1339 engage participants, measure mental health using validated scales, and connection individuals to
1340 resources and care. We will also gain insights about how these platforms impact access to care and
1341 perceived barriers to care in healthcare workers. Ultimately, the data can be used to better understand
1342 and improve strategies for protecting and supporting the mental health of healthcare workers
1343 throughout the COVID-19 pandemic and its associated phases, but also in the future.

1344 *11.3 Alternatives to Participation*

1345 Not participate in the study. As a reminder, all Penn Medicine and University of Pennsylvania have
1346 access to Cobalt resources, regardless of their participation in the study.

1348 *11.4 Data and Safety Monitoring*

1349 The study will be single-blinded and the study biostatistician will determine when to unblind the study.
1350 Given that the study compares the same process delivered as either a pull (usual care = Cobalt) or a
1351 push (intervention = Cobalt +) we believe risk is low. Nevertheless we will engage a 3-member
1352 independent Data and Safety Monitoring Board to oversee the trial. In accordance with conventional
1353 practices, we will not identify members in advance so as not to disqualify potential proposal reviewers.
1354 Given that the study compares the same process delivered as either a pull (usual care) or a push
1355 (intervention = well-being platform) we believe risk is low. Nevertheless, we will engage a 3-member
1356 independent Data and Safety Monitoring Board to oversee the trial. In accordance with conventional
1357 practices, we will not identify members in advance so as not to disqualify potential proposal reviewers.
1358 These three external investigators will have expertise in mental health and wellness, employee health,
1359 and digital health. In accordance with conventional practices, we will not identify members in advance
1360 so as not to disqualify potential proposal reviewers. The responsibilities of the DSMB will include:
1361 Reviewing the research protocol, consent, and plans for DSMB Evaluate the progress of the trial:
1362 recruitment, retention, data quality, and adverse events Protection of participant safety Ensure high
1363 standards for privacy and no breach of data security Provide written summary reports to the PI
1364 (Merchant) and investigators after convening Provide a written summary report to the NIH funding body
1365 if required This study will not have pre-specified stopping rules. The study will be single-blinded and the
1366 study biostatistician will determine when to unblind the study. DSMB members will be independent
1367 from any professional or financial conflict of interest with the research project and/or study
1368 investigators. The DSMB will meet at least once yearly via phone or virtual conference calls for the
1369 duration of the project. The DSMB will elect a Chair to moderate the meetings. At the initial meeting,
1370 the DSMB will review and approve all study protocols before study initiation to ensure participant
1371 safety. Protocols will include formal procedures for reporting and tracking all adverse reactions to the
1372 NIH and IRBs; tracking progress in the study; and identifying any need for premature termination of the
1373 protocol. At subsequent meetings, the DSMB will be provided with summary study progress reports and
1374 adverse events. The DSMB will provide a summary report following each meeting. We will not require
1375 the DSMB to conduct interim analyses of data prior to the end of the study. We ensure that there are no
1376 conflicts of interest with the DSMB study team or proposed institutions. Per our Data Safety and
1377 Monitoring plan, submitted on 10/14/2020, pages 7-9 outlines how the research team and DSMB will
1378 handle and report unexpected and adverse events. A brief overview is below: According to the Penn
1379 Manual for Clinical Research / Office for Human Research Protections, an unanticipated problem is any
1380 incident, experience, or outcome that meets all of the following criteria: unexpected; related or possibly

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1381 related to participation in the research; and suggests that the research places subjects or others at a
1382 greater risk of harm than was previously known or recognized. Since these are, by definition,
1383 unanticipated, it is impossible to state, a priori, what kind of unanticipated problems we expect in the
1384 trial. However, unanticipated problems in the trial might include differential rates across treatment
1385 groups of increased rates of mental health appointments or emotional distress. The trial will rely on a
1386 participants family or friend to report death and a participant self-report for other unanticipated
1387 problems.
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Cobalt Plus Data and Safety Monitoring Plan
14 October 2021

1. Summary of the Protocol:

A brief description of the study design (e.g., interventions, procedures, tests and scans, biospecimen collection, interviews and focus groups, study visits)

We will conduct a prospective two-armed randomized control trial to test the effect of tailored mental health support on self-reported HCW mental health (anxiety and depression) during the response and recovery phases of the COVID-19 pandemic. The control group will have access to Penn Cobalt, a digital platform for mental health care and support, which is usual care for all Penn Medicine employees. The Cobalt platform is web-based and is accessible from any device or desktop. Cobalt uses evidence-based surveys and assessments on mental health to triage individual users to curated content and appropriate group or individual support. The current, and usual care, model represents a digital version where resources are available for staff to access wellness and mental health services on their own. The usual care Cobalt model requires staff to initiate and navigate multiple steps on their own which include:

- identify a personal need for support,
- know where to seek support and care,
- schedule an appointment, and
- attend the appointment.

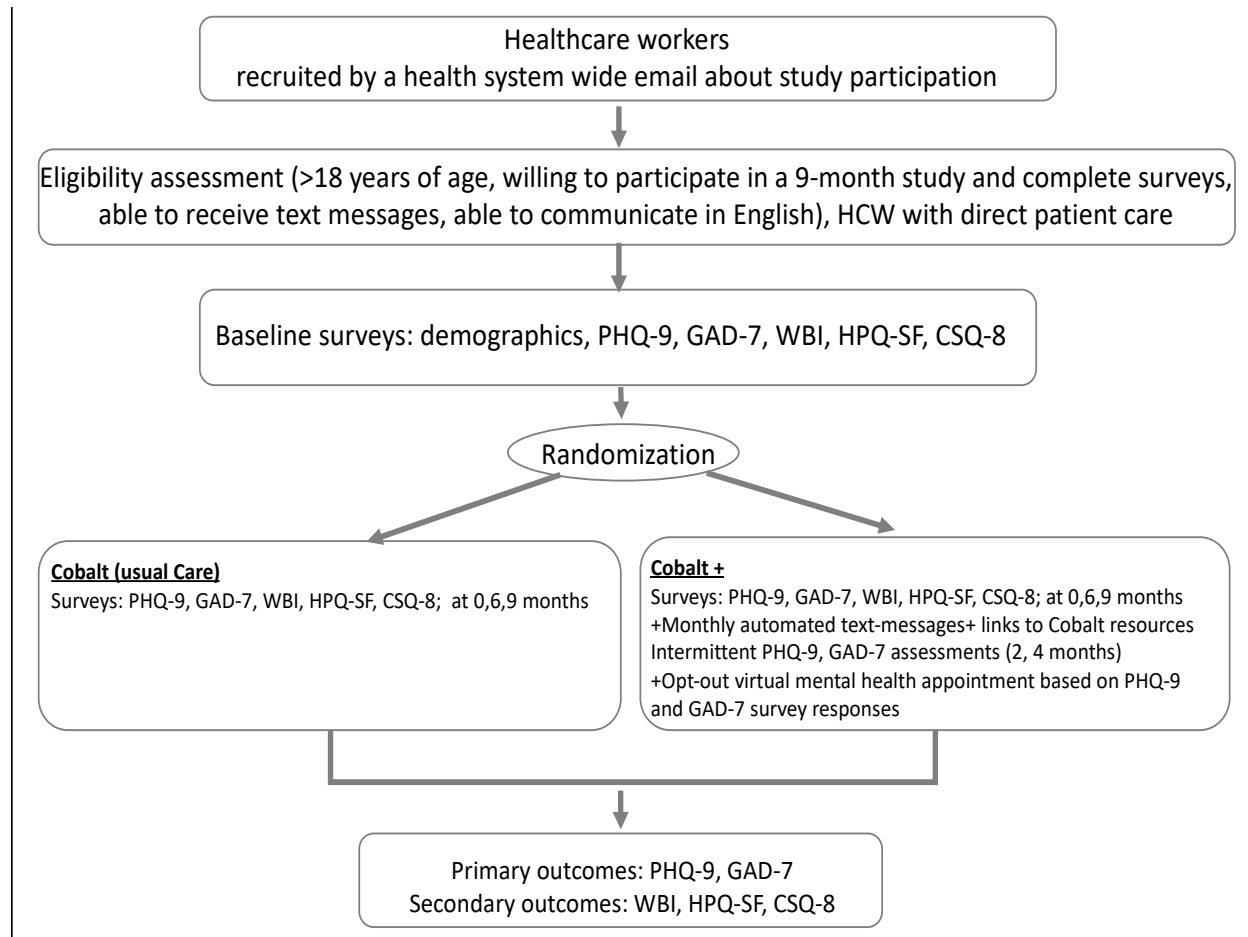
In this standard of care model, the individual staff member has to not only identify a need, but then “pull” the resources they need towards them. There may be several barriers to completing each step including time, stigma, lack of knowledge, among others. This is particularly relevant as mental health conditions can compromise insight, motivation, and decision making, thereby making self-directed engagement in care (“pull”) more challenging.

The RCT will compare the standard “pull” model with a new model, the intervention named “Cobalt+,” which will proactively reach out to and engage individuals in and attempt to reduce barriers inherent to identifying a need for and accessing mental health care. The intervention group will have access to the same Cobalt resources as those in the usual care group but will also receive a comprehensive suite of services delivered to them including:

- monthly automated text messaging engagement and links to Cobalt resources
- intermittent mental health assessments (PHQ-9, GAD-7) at enrollment, month 2, month 4 and month 6 which triage individuals to an appointment with a resilience coach, psychotherapist, or psychiatrist based on their results.

Of note, all employees will have access to Cobalt whether they are in the study or not. The proposed RCT will evaluate whether a proactive model of care delivery (the intervention named Cobalt+) impacts the primary outcome measure (depression and anxiety) and secondary outcome measures (well-being, satisfaction with access to care, and measures of work productivity [e.g. absenteeism]) as compared to usual care.

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1472 *Primary and secondary outcome measures/endpoints*

1473 The primary outcome will be depression and anxiety as measured by the Patient Health Questionnaire
1474 (PHQ-9) and General Anxiety Disorder (GAD-7) respectively.

- 1475 • PHQ-9 and GAD-7 have been validated and used in multiple studies and provide easy, simple
1476 scales to quickly assess for depression and anxiety. PHQ9 is a 9-item score which ranges from 0
1477 (least depressed) to 27 (most depressed).
- 1478 • GAD-7 is a 7- item scale which assess the frequency of anxiety symptoms over the past two
1479 weeks on a 4-point Likert-scale ranging from 0 (never) to 3 (nearly every day). The total score of
1480 GAD-7 ranged from 0 to 21, with increasing scores indicating more severe functional
1481 impairments as a result of anxiety.

1482
1483 Secondary outcomes are:

- 1484 • Well-being index: The Well-being index (WBI) is a nine-question survey validated for use in HCW
1485 populations and considered important to health systems in managing the well-being of their
1486 workforce.
- 1487 • Work productivity: To evaluate work productivity, we will use the World Health Organization
1488 Health and Work Performance Questionnaire (HPQ) short form. The HPQ is a validated self-
1489 report instrument designed to estimate the workplace costs of health problems with regard to
1490 reduced job performance, absence due to sickness, and work-related injuries and accidents. We
1491 will administer the short form which is an 11-question survey focused on absenteeism and
1492 presenteeism.

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- Satisfaction with care: Client Satisfaction with Care (CSQ)-8 is a brief 8-item unidimensional well-established scale for assessing patient’s satisfaction with overall outpatient health care. It has been shown to be reliable and valid in assessing care across a range of settings.

1497 All potential study participants will be screened via a self-report survey on REDCap (a HIPAA compliant survey and data capture platform). Criteria will be evaluated through REDCap branching logic.

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1500 *Sample size and target population*

1501 We aim to enroll 1250 participants with the anticipation that there will be 20% attrition.

1502

1503 We will recruit health care workers who provide direct patient care approximately 4 hours/week (on average 192 hours/ 48 weeks in a year) in the study time frame across the Penn Medicine Health System, this includes: the Hospital of the University of Pennsylvania, Penn Presbyterian Medical Center, Pennsylvania Hospital, Chester County Hospital, Penn Medicine Lancaster General Hospital and Penn Medicine Princeton. All sites will be included in one central Institutional Review Board system.

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1509 *Inclusion/exclusion criteria and how the criteria will be evaluated*

1510 There are no inclusion and exclusion criteria for any subpopulation based on race/ethnicity, age, gender, status as a vulnerable population. Considering the disproportionate impact of COVID-19 on underrepresented minority populations and historic barriers to access to mental health care for this population, we will aim for inclusivity of this group in study participation. Exploratory Aim 1 specifically seeks to determine if the effect of the intervention varies across patient subgroups (e.g., gender and race).

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1517 Eligibility criteria include:

- 1518 1) age 18 years or older
- 1519 2) regular, daily access to a smartphone
- 1520 3) able to communicate fluently in English (as the current Cobalt assessments and resources are in English at this time)
- 1521
- 1522 4) provide direct patient care (e.g., physicians, nurses, certified nursing assistants, lab technicians, radiology technicians, physical therapist, occupational therapist, pharmacists, pharmacy technicians, patient registration staff, receptionists/ patient intake coordinators, environmental service personnel) approximately 4 hours/week (on average 192 hours/ 48 weeks in a year) in the study time frame.
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1528 Eligible participants will be approached to complete informed consent. Any HCW meeting these criteria will be eligible to participate in the research; we will not exclude any potential participant based on a priori criteria.

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1532 Exclusion criteria include:

- 1533 1). Under 18 years of age
- 1534 2). does not have regular, daily access to a smartphone
- 1535 3). unable to communicate fluently in English (as the current Cobalt assessments and resources are in English at this time)
- 1536
- 1537 4). does not provide direct patient care approximately 4 hours/week (on average 192 hours/ 48 weeks in a year) in the study time frame
- 1538
- 1539 5). Not willing to provide informed consent.

1540 **2. Roles and Responsibilities**

1541 *Identification and description of individuals responsible for monitoring the trial (e.g., PI, ISM, DSMB),*
1542 *their roles, qualifications, and the frequency of the monitoring activities.*

1543 The Data and Safety Monitoring Board (DSMB) is an independent group of experts convened to protect
1544 the safety of research subjects and to ensure that the scientific goals of the project are being met. They
1545 will be an independent group of experts charged with reviewing study data for data quality and
1546 integrity, adherence to the protocol, participant safety, and study conduct and progress. During the
1547 intervention phase, the DSMB will monitor survey data (as available) and will monitor and investigate
1548 reports of safety concerns relating to study participants. The DSMB is a multidisciplinary group with a
1549 written charge, with members appointed by the PI. The DSMB can be advisory to the NIMH as needed.
1550 DSMB composition includes the following:

- 1551 (1) A physician with expertise in health systems and mental health conditions
1552 (2) A mental health epidemiologist with expertise in longitudinal analysis, field trials, and clinical
1553 trial data
1554 (3) An epidemiologist, statistician, computer scientist, and a mental health services researcher
1555 studying the outcomes, quality of care, and pharmacoepidemiology of patients with serious
1556 mental disorders

1557
1558 DSMB members will be independent from any professional or financial conflict of interest with the
1559 research project and/or study investigators. The DSMB will meet at least once yearly via phone or virtual
1560 conference calls for the duration of the project. The DSMB will elect a Chair to moderate the meetings.
1561 At the initial meeting, the DSMB will review and approve all study protocols before study initiation to
1562 ensure participant safety. Protocols will include formal procedures for reporting and tracking all adverse
1563 reactions to the NIH and IRBs; tracking progress in the study; and identifying any need for premature
1564 termination of the protocol. At subsequent meetings, the DSMB will be provided with summary study
1565 progress reports and adverse events. The DSMB will provide a summary report following each meeting.
1566 We will not require the DSMB to conduct interim analyses of data prior to the end of the study. We
1567 ensure that there are no conflicts of interest with the DSMB study team or proposed institutions.

1568
1569 Below are anticipated DSMB responsibilities:

- 1570 • Review the research protocol, informed consent documents and plans for data safety and
1571 monitoring;
1572 • Recommend subject recruitment be initiated after receipt of a satisfactory protocol;
1573 • Evaluate the progress of the trial, including periodic assessments of data quality and timeliness,
1574 recruitment, accrual and retention, participant risk versus benefit, and other factors that can affect
1575 study outcome;
1576 • Consider factors external to the study when relevant information becomes available, such as
1577 scientific or therapeutic developments that may have an impact on the safety of the participants or
1578 the ethics of the trial;
1579 • Review study performance, make recommendations and assist in the resolution of problems
1580 reported by the PI;
1581 • Protect the safety of the study participants;
1582 • Monitor and investigate suspected and unexpected severe adverse events (SAEs) and to
1583 unanticipated problems and determine if study is related or not;
1584 • Report to NIH on the safety and progress of the trial;
1585 • Make recommendations to the NIH concerning continuation, termination or other modifications of
1586 the trial based on the observed beneficial or adverse effects of the treatment under study;

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- 1587 • Ensure the confidentiality of the study data and the results of monitoring; and,
- 1588 • Assist the NIH by commenting on any problems with study conduct, enrollment, sample size, and/or
- 1589 data collection;
- 1590 • Provide written summary reports to the PI (Merchant) and investigators after convening;
- 1591 • Provide a written summary report to the funding body if required.

1592

1593 We propose the following for the DSMB meetings:

- 1594 • At the first meeting the DSMB will discuss the protocol, suggested modifications, and establish
- 1595 guidelines for study monitoring by the Board.
- 1596 • The DSMB will meet at least two times annually as determined by the Chairperson.
- 1597 • An emergency meeting of the DSMB may be called at any time by the Chair or by the NIH should
- 1598 participant safety questions or other unanticipated problems arise.
- 1599 • Meetings shall be closed to the public because discussions may address confidential participant
- 1600 data.
- 1601 • Meetings are attended by the Principal Investigators and members of their staff.
- 1602 • Meetings may be convened as conference or videoconference calls as well as in-person.

1603 **3. Trial Safety**

1604 *Description of any specific events that would preclude a participant from continuing the intervention*

1605 Death of a participant would constitute preclusion from continuing the intervention.

1606

1607 *Description of the potential risks and the measures in place to protect participants against foreseeable*

1608 *risks*

1609 There are minimal risks to participants in this study. The potential risks to study participants include:

- 1610 • Breach of confidentiality and privacy as information about each participant including their health-
- 1611 related information
 - 1612 ○ To protect against this, study team will closely adhere to Penn Medicine IRB protocols and
 - 1613 minimize the risk of breach of data and confidentiality, we will use secure, encrypted servers
 - 1614 to host the data and conduct the analysis.
- 1615 • Participants will also complete mental health surveys and the questions within these assessment
- 1616 tools may be sensitive or emotional for participants.
 - 1617 ○ To mitigate risks of self-harm, all study participants will sign an informed consent explaining
 - 1618 that all Penn Medicine employees have access to Cobalt resources regardless of their
 - 1619 participation in the trial. Study participants will also receive guidance on 24/7 confidential
 - 1620 hotlines and services if they experience thoughts of self-harm.
- 1621 • Individuals known to the participant who view messages or survey responses on the participant's
- 1622 phone.
 - 1623 ○ To protect against this, all participants will be informed of this potential risk and be
 - 1624 educated on how to password protect their device and limit access using the device's
 - 1625 inherent security features.

1626

1627 *Description of the consent/assent procedures (e.g., by whom, how and under*

1628 *what conditions will a subject be consented)*

1629 All study participants will independently read and sign the informed consent document on Way to

1630 Health, a HIPPA compliant platform and receive a pdf of the document after they enroll. The informed

1631 consent process informs the participant of all pertinent aspects of the study, provides contact

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1632 information for the study team should the participant have any questions, and indicates the study is
1633 voluntary and that the participant has the right to stop at any time. Participants will have access to the
1634 document at all times for their review.

1635
1636 *Description of the mechanisms in place to protect subject privacy (e.g., interviews will take place in a*
1637 *private room, whether results of testing data will be shared with participant's legally authorized*
1638 *representative, privacy for minors, secure means of communication between investigators and*
1639 *participant, e.g., telephone, web portal)*

1640 Mechanisms to protect subject privacy include:

- 1641 • To minimize the risk of breach of data and confidentiality, we will use secure, encrypted servers to
1642 host the data and conduct the analysis.
- 1643 • All portions of the Cobalt Plus data system will be password protected using a standard
1644 challenge/response system coupled with a user-specific identity system requiring users to log in with
1645 their personal PIN and password, which are checked before the login is completed.
- 1646 • Once the user is logged in, all activities are stamped with the user's PIN and date-time stamp.
1647 Knowledge of participant's and email addresses will be limited to staff who need to know that
1648 information.

1649
1650 *Description of the trial stopping rules for the study, if any (e.g., increased suicidal ideation, greater than*
1651 *expected morbidity or mortality rate).*

1652 No anticipated events are applicable to stopping the trial.

1653
1654 *Description of the plan for management of incidental findings (e.g., a brain tumor or potential structural*
1655 *abnormality discovered during a scan).*

1656 This study will not have incidental findings. All participants in control and intervention arms who
1657 complete assessments and are categorized as severe or at immediate risk for self-harm will be
1658 connected to resources and a mental health professional. No additional participant-level data will be
1659 collected and thus no other incidental findings will be captured.

1660
1661 *Description of the process for the disclosure of any conflicts of interest that may potentially challenge*
1662 *participant safety or bias the data and how the conflict will be managed*

1663 Co-Investigator David Asch reported a conflict of interest, to which this has been disclosed to all study
1664 team members and noted in the informed consent as, "Please note that there are other factors to
1665 consider before agreeing to participate such as additional procedures, use of your personal information,
1666 costs, and other possible risks not discussed here. Penn Medicine Cobalt resources and delivery system
1667 used as a part of this protocol was developed by inventors at Penn Medicine and if it were to be
1668 successful, the University of Pennsylvania would benefit financially."

1669
1670 *Description of the data security in place to protect the confidentiality of the data (e.g., password*
1671 *protected encrypted electronic records) and any limits to confidentiality (e.g., suicidal ideation, child*
1672 *abuse)*

1673 Data security practices in place to protect the confidentiality of the data include:

- 1674 • All data will be stored on the Way To Health Platform, a HIPAA compliant platform to research,
1675 develop and deploy evidence-based patient engagement strategies.
 - 1676 ○ Way to Health uses a role-based access control (RBAC) approach to assure that participant
1677 confidentially and study integrity is preserved.
 - 1678 ○ Access and visibility is primary governed by the role of the individual accessing the system.

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- 1679 ○ Access is granted by invitation only and can be revoked at any time. All Way to Health
- 1680 servers are managed by Penn Medicine Academic Compute Services (PMACS).
- 1681 ○ All data at-rest is stored on encrypted disks using encryption keys managed by Way to
- 1682 Health. Encrypted disks use AES encryption with a minimum of 256-bit keys, or keys and
- 1683 ciphers of equivalent or higher cryptographic strength.
- 1684 ○ User passwords are never stored in clear text; they are salted and hashed to eliminate data
- 1685 leakage. All data transmission is encrypted end to end using encryption keys managed by
- 1686 Way to Health.
- 1687 ○ Transmission encryption keys use a minimum of 2048-bit RSA keys, or keys and ciphers of
- 1688 equivalent or higher cryptographic strength (e.g., 256-bit AES session keys in the case of
- 1689 IPsec encryption).
- 1690 ○ Data downloads are generally prohibited by policy.
- 1691 ○ Where appropriate, most datasets are blinded of all personally identifiable information
- 1692 when exported for analysis. A limited number of exports including identifiers exist to assist
- 1693 research staff with recruitment tracking and study management efforts.
- 1694 ○ These datasets are only accessible to certain user roles. These user roles are required to
- 1695 sign and adhere to a W2H Security Agreement as described above.
- 1696 ○ To monitor ongoing usage of the system and identify unauthorized usage of the system, all
- 1697 access to the application and the database are logged automatically.
- 1698 ● All participants will be informed that the information they provide will be held in confidence to the
- 1699 extent that the law allows, but that the exception to this confidentiality is any disclosure of potential
- 1700 for immediate harm of themselves or others, such as active suicidal or homicidal ideation or child
- 1701 abuse. The participants will be notified prior to participation that if any of these issues are raised,
- 1702 the researchers will take whatever steps are necessary to protect the subject or others, including
- 1703 bringing risk of harm to the attention of the proper authorities. This applies only to direct verbal or
- 1704 written disclosure by the patient.

1705 **4. Reportable Events**

1706 *Description of the process and timelines (e.g., hours, days) for collecting and reporting Adverse Events*

1707 *(AEs), Serious Adverse Events (SAEs), and Unanticipated Problems Involving Risks to Subjects or Others to*

1708 *appropriate monitoring and regulatory entities (See NIMH Reportable Events Policy for definitions and*

1709 *timeframes)Collection of Serious Adverse Events and Unanticipated Problems*

1710 According to the Penn Manual for Clinical Research, and as defined by the NIMH, serious adverse events

1711 (SAE) are defined by one of the following:

- 1712 ● Death
- 1713 ● Life-threatening experience
- 1714 ● Inpatient hospitalization or prolongation of hospitalization
- 1715 ● Persistent or significant disability/incapacity
- 1716 ● Congenital anomaly/birth defect in the subject's offspring

1717

1718 In this trial, the following event is considered a SAE: death of a study participant.

1719

1720 According to the Penn Manual for Clinical Research, adverse events (AE) are events that:

- 1721 ● Are untoward or unfavorable medical occurrence in a human subject; and
 - 1722 ● Temporally associated with the subject's participation in the research, whether or not considered
 - 1723 related to the subject's participation in the research
- 1724

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1725 In this trial, the following events are considered an AE:

- 1726 • Information that indicates a change to the risks or potential benefits of the research, in terms of
- 1727 severity or frequency.
- 1728 • Breach of confidentiality.
- 1729 • Incarceration of a participant when the research was not previously approved under Subpart C and
- 1730 the investigator believes it is in the best interest of the subject to remain in the study.
- 1731 • Events that require prompt reporting to the sponsor.
- 1732 • Complaint of a participant when the complaint indicates unexpected risks or the complaint cannot
- 1733 be resolved by the research team.
- 1734 • Protocol violation (meaning an accidental or unintentional change to the IRB approved protocol)
- 1735 that placed one or more participants at increased risk, or has the potential to occur again.
- 1736 • Sponsor-imposed suspension

1737

1738 According to the Penn Manual for Clinical Research / Office for Human Research Protections, an

1739 unanticipated problem is any incident, experience, or outcome that meets all of the following criteria:

- 1740 • unexpected;
- 1741 • related or possibly related to participation in the research; and
- 1742 • suggests that the research places subjects or others at a greater risk of harm than was previously
- 1743 known or recognized

1744

1745 Since these are, by definition, unanticipated, it is impossible to state, a priori, what kind of unanticipated

1746 problems we expect in the trial. However, unanticipated problems in the trial might include differential

1747 rates across treatment groups of increased rates of mental health appointments or emotional distress.

1748 The trial will rely on a participant's family or friend to report death and a participant self-report for other

1749 unanticipated problems.

1750

1751 *Specific plan and timeframe for reporting IRB and/or ISM/DSMB actions to the NIMH (e.g., protocol*

1752 *violations, non-compliance, suspensions, terminations)*

1753 We will use the following procedures in the event of an AE, SAE, and protocol violation. In any of these

1754 instances, the research team will alert the PI and site PIs immediately (same business day).

1755 Subsequently, the PI and site PIs will submit a report within 10 working days (with one exception) of

1756 events that meet the definition of an unanticipated problem involving risks to subjects or others. The

1757 exception is if the SAE involved death and indicates that participants or others are at increased risk of

1758 harm, in which case the PI will be required to submit a report to the IRB within three days.

1759 Reports are submitted electronically through IRB's electronic submission system. The IRB staff (in

1760 conjunction with the IRB chair when necessary) will review reports and decide whether the event meets

1761 the definition of an unanticipated problem increasing risks to subjects or others. Events that meet these

1762 criteria will be considered unanticipated problems involving risks to participants or others, will be

1763 reviewed by the convened IRB, and will be reported accordingly.

1764

1765 See below for a flowchart of how the IRB handles these types of violations

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Relatedness	Expectedness	Reportable to IRB?	When to Report
Unrelated or Unlikely related	Expected and Unexpected	NO	N/A
Possibly, Probably, or Definitely related	Expected	NO	N/A
Possibly related	Unexpected	<p>YES* ONLY IF:</p> <p>The event suggests that the research places subjects or others at greater risk than was previously known or recognized (i.e., changes to the study conduct are required to mitigate risk and/or participants' willingness to participate may be adversely impacted)</p>	<p>EXPEDITED REPORTING WITHIN 10 bus. days</p> <p>Summarize at continuing review</p>
Probably or Definitely related	Unexpected	YES*	<p>EXPEDITED REPORTING WITHIN 10 bus. days</p> <p>Summarize at continuing review</p>
Probably or Definitely related death	Unexpected	YES*	<p>EXPEDITED REPORTING WITHIN 3 calendar days</p> <p>Summarize at continuing review</p>

*Includes serious and non-serious events.

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1767

1768 5. Data Management, Analysis, and Quality Assurance:

1769 *Identification of data sources (e.g., questionnaires, medical records, biospecimen collections, audio/video*
1770 *recordings)*

1771 In this study, we will:

- 1772 • utilize self-reported surveys and audio recordings as our data sources.
- 1773 • collect data from the Cobalt website for fidelity metrics including frequency of hyperlink use, text
- 1774 messages receiving a response, and participants request to stop receiving texts.
- 1775 ○ For the appointments, we will assess how often appointments are fulfilled or cancelled.

1776

1777 *Description of the security measures in place to protect data sources including how the data will be*
1778 *labeled and stored*

1779 The trial's security measures are below:

- 1780 • All study participants will provide written informed consent to their participation and will be
- 1781 assigned an ID number by which their data will be identified.
- 1782 • The research team will exercise extreme caution with identifiable private information. Patients
- 1783 randomized to the intervention arm will receive text messages from Way to Health.
- 1784 • All participants are instructed and agree by signing the document that they will not disclose
- 1785 personal health information (PHI) on the Way to Health texting platform and only respond to the
- 1786 text message prompts.
- 1787 • All PHI will be stored on Way to Health, a HIPAA compliant research platform stored on Penn
- 1788 Medicine Academic Computing Services (PMACS) will be the hub for the hardware and database
- 1789 infrastructure that will support the project.
- 1790 ○ PMACS requires all users of data or applications on PMACS servers to complete a PMACS-
- 1791 hosted cybersecurity awareness course annually, which stresses federal data security
- 1792 policies under data use agreements with the university. Curriculum includes HIPAA training
- 1793 and covers secure data transfer, passwords, computer security habits and knowledge of
- 1794 what constitutes misuse or inappropriate use of the server.
- 1795 • Password protection is used at the server and web portal levels for all transactions that allow entry
- 1796 and editing of data or provide access to sensitive subject data or administrative privileges.

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- 1797 ○ Additionally, all PHI data will be encrypted and linked to survey data through a study ID
1798 number, with linkage and de-encryption keys activated only by a user password for which a
1799 member of the research team has been given permission to access these sensitive data
1800 (Principal Investigator Dr. Merchant and project staff who are under the direct supervision
1801 of the PI).
- 1802 • The database management on these servers is built with multiple layers of security and follows best
1803 practices for securing sensitive data. The main levels of security are fourfold and include machine
1804 physical security at the IT facility at which the servers are housed, physical server security in the
1805 highly restricted server containment room, electronic server security (firewalls, passwords,
1806 encryption) restricting access to the machine, and directory access controls restricting access to
1807 these particular data.

1808

1809 *Quality assurance measures for subject recruitment, enrollment, enrollment targets, and for the validity*
1810 *and integrity of the data.*

1811 The study team has undergone trainings on Good Clinical Practice guidance to ensure that the rights,
1812 safety, and well-being of study subjects are protected and consistent with the principles that have their
1813 origin in the Declaration of Helsinki. Study participants will complete self-report surveys while usage
1814 meta-data will be extracted from the Cobalt platform.

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PROTOCOL CHANGES LOG

Summary of Amendments and Modifications:

Our IRB protocol included two components, Aim 1: randomized controlled trial and Aim 2: qualitative interviews. Aims 1 and 2 were conducted from 2021 – 2023. There were no major amendments to RCT study design. In May 2022, we increased the study sample from 1,250 to 1,275 to account for staff turnover and attrition rates. Most protocol modifications involved minor changes to survey instruments and consent procedures; adding and deleting key personnel to the study team.

File Name	Date of Submission	Approval date	Summary	Rationale
initial-sub-1	4/12/2021	5/12/2021	Original IRB protocol submission	Initial trial protocol submission
Mod-2	10/14/2021	11/23/2021	informed consent	updated informed consent
			grant application	submitted NIH grant application
			Data Safety and Monitoring Board plan	submitted Data Safety and Monitoring Board plan
			Recruitment materials	Updated recruitment letter
			Surveys	Modified study surveys
Mod-3	12/9/2021	12/13/2021	informed consent	updated informed consent
			text message intervention	updated text message intervention
			Data Safety and Monitoring Board plan	submitted Data Safety and Monitoring Board plan
			Recruitment materials	Updated recruitment letters, flyers, scripts, and infographics
			Surveys	Modified screening survey and study surveys
Mod-4	1/10/2022	...	informed consent	updated informed consent
			Recruitment materials	Updated recruitment letter
			Surveys	Modified screening survey and study surveys
			Safety procedures	Provided additional scripts and tools for self-harm safety assessments
Mod-5	3/3/2022	3/28/2022	Revised informed consent document	Received feedback to strengthen informed consent document
			Revised HSERA application	Received feedback to clarify HSERA protocol

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Mod-6	4/4/2022	4/12/2022	Revised outreach materials	Revised text message answer choices, revised outreach and welcome email
			Edited compensation material	Migrated to Virtual Visa ClinCards
			Edited month 6 survey	Included multiple answer choices
Mod-7	4/22/2022	5/3/2022	Revised outreach materials	Edited welcome email
			HSERA protocol	Receive de-identified demographic information from Penn HR
			Edited month 6 survey	Added clarifying question
Mod-8	5/31/2022	6/6/2022	HSERA protocol	Increased attrition from 25% to 27.5%
			Edited month 6 survey	Edited question
Mod-9	7/11/2022	7/13/2022	HSERA protocol	Updated study personnel
			Edited month 6 survey	Simplified Cobalt use questions
Mod-10	11/7/2022	12/8/2022	Last text message in Aim 1	Included safety resources in last study text message to all participants
			Edited month 9 survey	Simplified and revised follow up question about Cobalt use; added question about clinical hours
			Updated Aim 2: qualitative interview guide	Updated questions
			Updated Aim 2: qualitative interview informed consent	Updated informed consent to mirror Aim 1
			HSERA protocol	Updated design to include new data storage, Aim 2 coding schema
Mod-11	1/3/2023	1/13/2023	Updated personnel	Added Sarah Beck and Rachel Howell as study personnel
Mod-12	2/20/2023	3/17/2023	Continuing Review Application	Submitted Continuing Review Application to the IRB
Mod-13	3/18/2023	4/4/2023	Updated Aim 2; Updated personnel	Added study personnel; provided clarification on Aim 2 sampling methods

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Original Statistical Analysis Plan

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1829 We will conduct an intent to treat (ITT) analysis. The ITT analysis will include all randomized participants
1830 in the groups to which they were randomly assigned. Baseline demographic and clinical characteristics
1831 will be reported as frequency and percent for categorical variables and median and distribution for
1832 continuous variables. We will compare baseline characteristics between intervention and control arms
1833 using t-tests for continuous variables and chi-squared tests for categorical variables. The goal of these
1834 comparisons will be to determine if the two arms are balanced on baseline variables after
1835 randomization. Our primary analysis will focus on the difference in PHQ-9 and GAD-7 scores at 6 months
1836 between the two arms. We will estimate and test differences in means between arms using two- sample
1837 t-tests and generalized linear models that account for baseline measurements of PHQ-9 and GAD-7.
1838 Missing data will be assessed for patterns and multiple imputation will be used if deemed appropriate.
1839 Baseline covariates that are found to be imbalanced between arms may be adjusted for in the model if
1840 they were deemed to be potential confounders a priori to adjust for potential confounding and for
1841 efficiency gain. We will use all available PHQ-9 and GAD-7 scores on eligible patients from randomization
1842 through the last observation. A $p < 0.05$ will be deemed statistically significant but emphasis will be placed
1843 on point estimates and confidence intervals.

1844

1845 Secondary outcomes of mental healthcare utilization, satisfaction with connection to services, and
1846 qualitative feedback on mobile engagement will also be modeled using GEE with mean models specified
1847 based on the distribution of the specific outcome (e.g. Poisson or negative binomial for number of
1848 mental healthcare visits, logit for binary responses). Potential associations between system-level or
1849 regional level case burden and PHQ-9 and GAD-7 scores at baseline and over-time will be assessed with
1850 generalized linear models and GEE.

1851

1852 Exploratory Aim 1: Statistical approach: The statistical approach for studying HTE will be to test for the
1853 statistical interaction between the intervention and race and separately by gender in the GEE models
1854 described above. Although our study was not designed specifically to detect HTE, if 20% of our trial
1855 participants are Black (based on targeted recruitment efforts), our study will achieve 80% power
1856 (assuming type I error of 0.05) to detect a 1.8 difference in mean GAD-7 scores and a 2.0 difference in
1857 mean PHQ-9 scores between arms at 6 months. We anticipate that at least 50% of participants will be
1858 female. Hence, our study is powered to detect a 1.2 difference in mean GAD-7 scores and a 1.3
1859 difference in mean PHQ-9 scores between arms at 6 months among women.

1860

1861 Aim 2: Power: no power calculation will be performed for this qualitative aim consistent with prior
1862 qualitative aims we will aim to interview 80 participants from Aim 1 and evaluate themes until
1863 saturation Analysis: Using thematic analysis, we will analyze HCW interview transcripts to identify
1864 recurring themes in attitudes and beliefs toward mental health, well-being, and mental health care or
1865 resources. Interview audio will be transcribed and uploaded into NVivo software (available as a Penn
1866 resource). In total we plan for up to 80 semi-structured interviews, or until inductive thematic saturation
1867 is reached in each group meaning no new themes are emerging. Analysis of qualitative, semi-structured
1868 interviews utilizes a series of systematic steps in transcribing, developing a code for thematic content,
1869 and subsequent coding of interviews. A modified grounded theory approach will be used to evaluate
1870 interview transcriptions. Analysis will begin shortly after the first few interviews are completed. An
1871 emergent, iterative open coding process will be followed and two trained coders from the research
1872 team will jointly read five transcripts and draft the outline of a codebook. Each coder will then
1873 independently code five more transcripts and adjust the codebook as needed. We will review the codes,

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1874 resolve discrepancies and finalize coding procedures. Following adjudication of any areas of discrepancy,
1875 the research team coders will be assigned batches of transcripts for independent coding, sharing 25% of
1876 the transcripts in each batch for ongoing inter-rater agreement assessment. We will review coding for
1877 interrater reliability, measured by Cohens kappa (0.8), and overall comprehensiveness. If a high kappa is
1878 not achieved, further double coding and refining of the code will continue. This approach to coding and
1879 analyzing qualitative data has been widely used. Strategies used to ensure reliability and validity in the
1880 qualitative data will include a comprehensive audit trail, checks between coders, team debriefing, and
1881 corroboration of findings across participants.

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1910 Amendments to the Statistical Analysis Plan

1911 All amendments to the original SAP were made prior to unblinding of the data analyst and prior to
1912 access to outcome data. We omitted satisfaction to access to mental health services as a secondary
1913 outcome analysis since it was underpowered to detect changes over time.

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Final Statistical Analysis Plan

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