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Implementing Home Office Work at a Large Psychiatric University Hospital in Switzerland During the COVID-19 Pandemic: Field Report

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Abstract

Background: During the COVID-19 pandemic in 2020, psychiatric hospitals all over the world had to adapt their services to the prevailing governmental regulations. As a consequence, home office use and telepsychiatry boomed.

Objective: The purpose of this study was to evaluate the potential of home office use, its adoption, and the association of home office use with employees' mental health in a large psychiatric university hospital in Switzerland.

Methods: We obtained and analyzed home office implementation and use data from the psychiatric university hospital’s information technology services. We also conducted a cross-sectional web-based survey to assess the employees’ attitudes toward the clinic’s crisis management during the COVID-19 pandemic in early 2020. Part of this web-based survey consisted of questions about home office use between March and June 2020, attitudes toward home office implementation, and mental health. Three mental health measures assessed depressive symptoms (Patient Health Questionnaire [PHQ]-2), anxiety (General Anxiety Disorder [GAD]-2), and stress factors (stress module of the PHQ-D); a cut-off score $\geq 3$ was used for the PHQ-2 and GAD-2.

Results: Of the 200 participating employees, 69 reported that they had worked from home at least partially (34.5%). Home office use differed significantly across professional groups ($\chi^2_{16}=72.72, P \leq .001, n=200$). Employees experienced neither depressive symptoms (mean 0.76, SD 1.14) nor anxiety (mean 0.70, SD 1.03). The employees reported minor psychosocial stressors (mean 2.83, SD 2.92). The number of reported stress factors varied significantly across groups with different levels of home office use ($\chi^2_{4}=9.72, P=.04$).

Conclusions: In general, home office implementation appears to be feasible for large psychiatric hospitals, however, it is not equally feasible for all professional groups. Professional groups that require personal contact with patients and technical or manual tasks must work onsite. Further evaluation of home office use in psychiatric hospitals up to the development of clinics that function merely online will follow in future research. The situation created by the COVID-19 pandemic served as a stepping stone to promote home office use and should be used to improve employees’ work–life balance, to save employers costs and foster other benefits.

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KEYWORDS

home office; psychiatry; employees; mental health; depression; anxiety; stress factors; Patient Health Questionnaire; PHQ-2; General Anxiety Disorder; GAD-2; PHQ-D; COVID-19; pandemic
Introduction

Looking back on 2020, COVID-19 had the world firmly in its grip, with over 80 million confirmed cases and more than 1.8 million associated deaths [1]. After its first detection in China at the end of 2019, it spread rapidly around the globe. As a consequence, governments all over the world imposed major restrictions on the general population such as face masks requirements, social distancing requirements, and general lockdowns. In Switzerland, a national lockdown was declared shortly after the first confirmed cases in the country [2]; the general population was obliged to stay at home, shops were closed, and employees were urged to work from home, with only a few exceptions.

Researchers have reported numerous psychological effects of the pandemic [3-13]. Fear of transmission, isolation, unemployment, and economic recession were associated with increased distress [9,10], anxiety [9,10], and depression [4,9,10]. In particular, women [4,5,8,10], young people [7,8,10], individuals who lost their job [7,8,10], and individuals with a history of mental illness [10] seemed to suffer from negative consequences. Moreover, health professionals and mental health professionals reported increased distress during the pandemic, especially when facing COVID-19 infections at their workplace [3,5,6,14]. Accordingly, mental health services also face a rather high demand for psychiatric treatment during the ongoing pandemic [15,16]. However, it was difficult to offer treatment within the scope of the prevailing governmental measures (such as social distancing). This problem had to be solved, practically overnight, in psychiatric hospitals around the world. Traditional operating processes were adapted—new and especially safe approaches to offer psychiatric treatment while also preventing COVID-19 infections among patients and professionals.

Home office and telepsychiatry, the process of providing health care from a distance through technology [17], therefore, found their way into the daily routines of doctors, psychologists, and nurses in large psychiatric hospitals. Home office implementation has been associated with several benefits during the pandemic (ie, reduced COVID-19 infection risk due to reduced personal contact with co-workers and patients and less commuting) and beyond this extraordinary situation (ie, increased perceived autonomy in employees, higher job satisfaction, and less work–family conflicts [18-20]). Fadinger and Schymik [21] showed that home office use during the COVID-19 pandemic was associated with a lower infection risk and was less costly than confinement. However, home office use also exerts potentially detrimental effects on social relationships [18]. Moreover, home office work may not be feasible for all professional groups (eg, construction workers, nurses). Rutzer and Niggli [22] calculated a home office index that indicates the probability of being able to work from home (where 0 indicates that home office work is not possible, and 1 indicates that all work can be done from home). They found that the home office index differed between economic sectors as well as between professional groups. For the public health sector, the authors reported a home office index of 0.19 because there are many positions for which home office is not or minimally feasible. Because there are situations in which in-person treatments may be necessary, the implementation of home offices may be challenging for psychiatric hospitals.

However, numerous studies [23-27] since the 1990s have shown that telepsychiatry is comparable to in-person psychiatry (onsite psychiatric assessments and treatments) with respect to feasibility, validity, reliability of diagnoses, therapeutic alliance, and patient satisfaction, and doctor satisfaction. In addition, telepsychiatry increases accessibility for people living in rural areas, saves commuting time, and reduces costs [28]. However, there are also some challenges. First, certain technical prerequisites (ie, suitable devices for patients and health care professionals, and a stable internet connection) are required. Second, data security has to be ensured. Third, telepsychiatry may not be appropriate for certain populations (eg, suicidal or involuntarily treated patients and patients who struggle with navigating web-based platforms) [28].

Regarding these challenges, the implementation of telepsychiatry is an extremely complex and challenging process for mental health professionals, in general, and for large psychiatric hospitals, in particular. Before the COVID-19 pandemic, web-based treatment was not widely used in psychiatric hospitals in Switzerland; onsite treatment was the standard. However, the pandemic “has served as a catalyst for the rapid implementation and acceptance of telemental health” [28] as an effective option to deliver mental health services. Telepsychiatry (and home offices) suddenly became an integral part of work in psychiatric hospitals. However, the question arises—how will large psychiatric hospitals successfully implement home offices during the COVID-19 pandemic? We explored this issue by investigating the following research questions: How did home office use change over the course of the year 2020? Which employees were able to work in home office? How did the implementation of home office work from the employees’ viewpoint? Is home office use associated with the mental health of employees?

Methods

Background

The first case of COVID-19 in Switzerland was confirmed on February 25, 2020, and the first case in Basel was confirmed on February 27, 2020. Shortly afterward, on March 16, the Federal Council simultaneously declared extraordinary circumstances and a national lockdown [2,29]. Subsequently, the management board of the Psychiatric University Clinics Basel (UPK) requested that all employees for whom it was possible work from home. On June 19, 2020, the Federal Council eased the restrictions and ended the national status of extraordinary circumstances [2]. In autumn, the number of COVID-19 cases in Switzerland rose again, which led to renewed restrictions. On October 19, 2020, the Federal Council, therefore, recommended that employees work from home whenever possible [30]. These restrictions remained in place for the rest of the year and beyond. In 2020, a total of 8 patients with COVID-19 were treated at UPK.
Research Design

We aimed to evaluate the potential of home office use, actual home office use, and the association of home office use with employees’ mental health for the staff from a large psychiatric university hospital (>1200 employees) in Switzerland. Background information about home office implementation and use were gathered by the hospital’s chief information officer (CM), and web-based survey data were collected as part of a retrospective analysis to assess the employees’ attitudes toward the clinic’s crisis management during the COVID-19 pandemic in early 2020. The cross-sectional web-based survey was mandated by the management board of UPK as a consequence of the far-reaching policies and extensive home office implementation in March 2020.

Participants and Procedures

Home office users had access to the hospital’s home office environment (ie, their desktop and preinstalled apps) through Citrix Workspace (Citrix Systems Inc, 2020), with access from a large range of end devices with a broad selection of supported operating systems. This infrastructure had already been put into place before the pandemic but had only been used by a very limited number of employees. The email service was provided by internal Office Outlook servers (Windows 10; Microsoft Inc). In addition, a webmail service offered flexible email checking. Zoom (Zoom Video Communications Inc) was used for videoconferences. It was introduced at UPK in March 2020 to ensure efficient exchange between teams and individual employees and to provide a platform for telepsychiatry.

For the web-based survey, we estimated the required sample size using G*Power (version 3.1). We assumed medium effect sizes ($f=0.25$ [31]), $\alpha=.05$, and power 0.8 [32]; the required sample size was 196. Based on expected attrition, we included 252 persons in the web-based survey. Because data were collected as part of a retrospective survey to assess crisis management, professional groups with a direct and significant effect on crisis management were included in the study: members of the crisis management group (n=23), supervising physicians, psychologists and nurses (n=93), link nurses (n=28), and employees of the ward established for COVID-19–positive patients (n=8). Link nurses are responsible for hospital hygiene on their division; they connect their division to the authorized representative for hospital hygiene of the canton Basel-City. In addition, a representative sample (with respect to profession, organizational unit, and years of professional experience) was randomly selected (n=100) from all other employees of UPK Basel. Exclusion criteria were employees with a small workload (<50%) and employees such as interns, medical student assistants, or without clinical or administrative duties. We assumed that these employees had not sufficiently been affected by the hospital’s clinical crisis management.

Employees (n=252) were asked by email on June 10, 2020 to fill in the web-based survey. They received a reminder 7 days later and on June 26, 2020, which was 3 days before the assessment phase ended. A total of 200 employees (79.4% of the 252 initially approached employees) completed the web-based survey (Figure 1). Employees did not receive any compensation for their participation in the study. Data were anonymized and stored on a local server of the department of Quality and Processes at UPK Basel. Participants agreed to the publication of anonymized data.

No ethics committee approval was necessary; at the request of the authors, the Ethics Committee of Northwestern and Central Switzerland confirmed that these analyses do not fall within the scope of the Human Research Act (article 2 paragraph 1 [33]) as they are not defined as research concerning human diseases or concerning the structure and function of the human body.

![Figure 1. Sample composition of the web-based survey. UPK: Psychiatric University Clinics Basel.](https://mental.jmir.org/2021/9/e28849)
Measurements

Home Office Use

Frequency and distribution of videoconferences on Zoom were retrieved from the administrator account of the hospital’s chief information officer (CM). Data were downloaded on January 15, 2021. The frequencies of videoconferences over the course of the year 2020 were included as a proxy for home office use. Due to data protection regulations, detailed information about access to the home office environment are deleted after 30 days at UPK; therefore, these data were not available.

The web-based survey (Multimedia Appendix 1) asked “‘Do you work from home?’” Response options were “Yes, always”; “Yes, partially”; “No, it is not possible for my position”; “No, I did not want to”; or “No, I was rejected to work from home.” Employees’ rated several statements that assessed their attitudes toward the home office implementation (eg, “I have the necessary IT infrastructure available at home.”) on a 5-point Likert scale from “strongly disagree” to “strongly agree.”

Depression

The Patient Health Questionnaire (PHQ)-2 [34] assesses main criteria of depressive disorders with 2 items: “little interest or pleasure in doing things” and “feeling down, depressed, or hopeless.” Participants were asked to rate the frequency of these symptoms over the previous 2 weeks on a 4-point Likert scale from 0 (not at all) to 3 (nearly every day). The sum ranges between 0 and 6, and scores ≥3 have been shown to reliably screen for a current depressive episode [34]. This brief version of the PHQ-8 shows comparable reliability and validity for screening [34-36].

Anxiety

The General Anxiety Disorder (GAD)-2 scale [34] contains the first 2 items of the GAD-7 to assess core criteria of general anxiety disorder; a score ≥3 has been identified as the optimal cut-off for screening purposes. The GAD-2 has been shown to be a similarly valid and reliable screening instrument for all anxiety disorders (such as panic, social anxiety, and posttraumatic stress disorder) compared to the GAD-7 [34,36,37].

Stress

The stress scale of the PHQ–D [38] consists of 10 items to assess common psychosocial stressors (eg, financial status, family relationships, work). Each item is rated on a scale from 0 to 2 (not bothered, bothered a little, bothered a lot) [39]. The sum score (between 0 and 20) represents level of experienced stress. A score of 0 represents no stress factors, whereas a score of 20 stands for heavily experienced stress factors. No valid cut-off score is currently available for this stress scale [40]. In this sample, the stress scale of the PHQ–D showed acceptable to good internal consistency (Cronbach =0.78) [41]. The German version has been found to be a valid, reliable, and well-accepted screening instrument [38].

Demographic Information

Sociodemographic data, including gender, professional group, and workload, were collected.

Statistical Analysis

Descriptive statistics are presented. Frequencies and percentages are given for nominal data, and for interval data (ie, the questionnaires about mental health), mean and standard deviation were calculated. We divided the sample, first, on the basis on professional groups (ie, doctors, psychologists, nurses, employees working in administration, and others). The category others consisted of employees who did not belong to any of the other groups (ie, trainees, housekeeping, social services, etc). Second, we categorized the sample by home office use responses (ie, “Yes, always”; “Yes, partially”; “No, it is not possible for my position”; “No, I did not want to”; and “No, I was rejected to work from home”). The distribution of participants among the 5 home office groups were compared across the 5 professional groups using the Fisher exact test because group sizes were small. Cramer V was calculated to estimate the effect size.

Due to the nature of sample structure (ie, small group sizes), nonparametric tests (namely, the Kruskal-Wallis test) were used for comparisons regarding psychological well-being across home office groups and across professional groups. Exact calculation of the Monte-Carlo significance was chosen because of the small group sizes. For the final analysis, because some groups were too small to reliably conduct posthoc analyses; therefore, we used the Mann-Whitney U test to compare the 2 groups only—affirmative (“Yes, always” and “Yes, partially”) and negative (“No, it is not possible for my position”; “No, I did not want to”; and “No, I was rejected to work from home”). Statistical analyses were performed using SPSS Statistics for Mac OS (version 27.0; IBM Corp), and graphical analyses were conducted in Excel for Mac (version 16.45; Microsoft Inc). Given the exploratory nature of this study, outliers were included in all analyses and no correction for multiple testing was applied. For all analyses, 2-tailed tests were used, and a significance level at 5% was chosen. Missing values were excluded pairwise.

Results

In total, 7173 videoconferences took place in 2020. More videoconferences were held in April 2020 (n=1788) than in any other month that year (Figure 2). In the month of April, the daily maximum was 125 videoconferences (on Tuesday April 20, 2020). Since then (over the months), the number of videoconferences has gradually decreased. For example, the daily maximum in June was 39 videoconferences (on Tuesday June 1 and Thursday June 3, 2020). In August, the daily maximum was 17 videoconferences (on Thursday August 12, 2020). The number of videoconferences again increased, to over 900 videoconferences per month in November and December. More detailed information (eg, videoconference participants or purpose) was not available due to data protection regulations.
Of the 200 web-based survey respondents, 115 (57.5%) were female. More than half of the sample (117/200, 58.5%) worked full-time (ie, level of employment between 90% and 100%), whereas the rest (n=83, 41.5%) worked between 50 and 89% (employees with a workload below 50% were excluded in advance).

The majority of employees continued to work at their original workspace (131/200, 65.5%) rather than working from home (69/200, 34.5%). For the majority of employees who were still working in person at the hospital, it was not possible for them to work from home because of their position (104/131, 79.4%). This seemed to be true for nurses in particular; 84.9% (62/73) reported that home office was not possible. In other professional groups, home office work seemed to be more feasible. Only 20% of employees in administration (6 out of 30) stated that home office was not possible. Most employees who worked from home worked part-time in person at their original working environment (61/69, 88%). Few employees worked full-time from home (8/69, 12%). Of 200 employees, 3 were denied the possibility of working from home (1.5%). The distribution across the 5 home office groups (Table 1) varied between the professional groups ($\chi^2 = 72.72, P \leq .001, n=200$). The effect size ($V = .31$) indicated a medium effect [42].

### Table 1. Home office status (Did you work from home?) in the 5 professional groups during the COVID-19 pandemic in early 2020.

<table>
<thead>
<tr>
<th>Responses</th>
<th>Doctors (N=42), n (%)</th>
<th>Psychologists (N=23), n (%)</th>
<th>Nurses (N=73), n (%)</th>
<th>Administration (N=30), n (%)</th>
<th>Others (N=32), n (%)</th>
<th>All (N=200), n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, always</td>
<td>1 (2.4)</td>
<td>1 (4.3)</td>
<td>0 (0.0)</td>
<td>3 (10.0)</td>
<td>3 (9.4)</td>
<td>8 (4.0)</td>
</tr>
<tr>
<td>Yes, partially</td>
<td>19 (45.2)</td>
<td>14 (60.9)</td>
<td>7 (9.6)</td>
<td>11 (36.7)</td>
<td>10 (31.3)</td>
<td>61 (30.5)</td>
</tr>
<tr>
<td>No, it was not possible for my position</td>
<td>17 (40.5)</td>
<td>6 (26.1)</td>
<td>62 (84.9)</td>
<td>6 (20.0)</td>
<td>13 (40.6)</td>
<td>104 (52.0)</td>
</tr>
<tr>
<td>No, I did not want to</td>
<td>4 (9.5)</td>
<td>1 (4.3)</td>
<td>4 (5.5)</td>
<td>10 (33.3)</td>
<td>5 (15.6)</td>
<td>24 (12.0)</td>
</tr>
<tr>
<td>No, I was rejected to work from home</td>
<td>1 (2.4)</td>
<td>1 (4.3)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>1 (3.1)</td>
<td>3 (1.5)</td>
</tr>
</tbody>
</table>

aEmployees who do not belong to any of the other categories (ie, trainees, housekeeping, social services, etc).

Employees who worked at least partially in home office (n=69) rated their work from home as a mainly positive experience. The majority of this subgroup had the necessary information technology infrastructure available at home (50/65, 76.9%) and promptly received a home office account from the information technology department (46/49, 93.9%). Most employees (55/66, 83.3%) had a quiet working space at home. Videoconferences via Zoom connected those working from home and those in the hospital. Zoom was seen as suitable for videoconferences or web-based therapy by 73.1% (106/145). Whereas the program was provided in time for 81.4% of the employees (131/161), many did not have sufficient equipment (eg, headset, webcam) for videoconferences (75/148, 50.7%). Almost half of the sample (83/170, 48.8%) reported that the help desk service of the information technology department was not available as usual.

Table 2 shows descriptive statistics of the 3 mental health measures (depression, anxiety, and psychosocial stressors). This sample seemed to experience only mild psychological distress, if at all. On average, employees reported minor psychosocial stressors (mean 2.83, SD 2.92). The only 2 exceptions were employees who had to work at home full-time and those who were rejected to work from home. Both groups reported a rather high number of psychosocial stressors (mean 5.13, SD 4.19 and mean 7.00, SD 5.20, respectively).
A Kruskal-Wallis H test revealed that the 5 home office groups differed concerning their reported number of stress factors ($\chi^2 = 9.72, P = .04$). No significant differences were found for anxiety ($\chi^2 = 8.56, P = .07$) or depression scores ($\chi^2 = 3.62, P = .47$). A Mann-Whitney U test showed that the 2 groups (affirmative and negative) did not differ regarding reported stress factors ($\chi^2 = 3344.50, P = .17$). The 5 professional groups also did not differ on any of the psychological scales (depression: $\chi^2 = 8.06, P = .08$; anxiety: $\chi^2 = 3.17, P = .54$; stress factors: $\chi^2 = 7.01, P = .13$).

**Discussion**

The aim of this field report was to describe the implementation of home office work for UPK staff in Basel, Switzerland during the COVID-19 pandemic. The national lockdown declared by the Swiss government in March 2020 boosted home office use, but home office use was not equally frequent in the different professional groups. UPK employees experienced no or only mild psychological distress during the current COVID-19 pandemic. Thus, the implementation of home office use for UPK staff can be seen as relatively successful; however, the broad implementation of home office in large psychiatric hospitals has to be viewed as a process that has just started [18].

COVID-19 and consequently declared governmental restrictions have provided a major impetus to telepsychiatry and home office implementation in Switzerland and all over the world [28]. At UPK, the use of the videoconferencing fluctuated along with governmental restrictions. In March 2020, the number of videoconferences increased sharply with the declaration of the national lockdown. Within days, the necessary technical requirements to offer videoconferences were set up by the hospital’s information technology department. Home office users grew from less than 100 to almost 400 employees, as every person had to work from home as long as the extraordinary circumstances [2,30] prevailed. The dramatically increasing capacity utilization, and lack of apps in the hospital’s home office environment were 2 major challenges in this time according to the hospital’s chief information officer. In June 2020, the Federal Council eased the restrictions [2], which led to a lower number of videoconferences—less than 250 per month—between July and September 2020. With the renewed rise of coronavirus infections in October 2020, the Federal Council again recommended that employees should work from home if possible [2,30]. The number of videoconferences, therefore, increased again at the end of this year, to almost 1000 videoconferences per month in the UPK Basel.

Interestingly, only one-third (69/200, 34.5%) of the UPK employees who responded to the web-based survey worked at least partially from home. The rest—approximately two-thirds—did not work from home at all. This ratio is in line with the home office index of 0.19 reported by Rutzer and Niggli [22] for the public health sector, where 19% of the positions or tasks can potentially be performed from home. Moreover, these findings also support the large differences between professional groups that have been reported [22]. Almost two-thirds of the psychologists (65.2%) answered that they work at least partially from home whereas only every tenth nurse did (9.6%). These percentages are in line with the home office indices reported by Rutzer and Niggli [22].

These large differences across professional groups correspond to work-related factors. According to Rutzer and Niggli [22], for employees in positions that require personal contact with clients or patients as well as mainly technical or manual tasks (eg, administering injections) must work in person (therefore, make home office impossible). Strategic, administrative, or creative tasks, on the other hand, can easily be completed from home (or any other place), which includes psychotherapeutic treatment [22]. As web-based assessments and treatment has been shown to be comparable to in-person appointments [23-25], home office use seems to be feasible even for large psychiatric university hospitals; however, as mentioned above, feasibility strongly differs between professional groups and may also depend on other factors (eg, inpatient vs outpatient services).

At UPK Basel, many of the employees in our sample did not want to work from home (24/200, 12.0%), especially those in administration (10/30, 33.3%). This choice belonged to the employees as the Federal Council only recommended—not required—that employees to work from home in March 2020. The attractiveness of home office use may therefore also depend on other factors (such as the employee’s personal living conditions). In spring 2020, more than 1200 employees of the hospital had to work from home as long as the extraordinary circumstances [2,30] prevailed. The dramatically increasing capacity utilization, and lack of apps in the hospital’s home office environment were 2 major challenges in this time according to the hospital’s chief information officer. In June 2020, the Federal Council eased the restrictions [2], which led to a lower number of videoconferences—less than 250 per month—between July and September 2020. With the renewed rise of coronavirus infections in October 2020, the Federal Council again recommended that employees should work from home if possible [2,30]. The number of videoconferences, therefore, increased again at the end of this year, to almost 1000 videoconferences per month in the UPK Basel.
Acknowledgments

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Authors' Contributions

CGH designed the study, and JSK and CGH wrote the initial draft of the paper. JSK, RG, and CM collected the data. JSK, JM, and CGH analyzed and interpreted the data. All authors have contributed to, read, and approved the final version of the manuscript. JSK has full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Web-based survey items: home office and information technology services.

References


Abbreviations

GAD: General Anxiety Disorder
PHQ: Patient Health Questionnaire
UPK: Psychiatric University Clinics Basel

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Implementation of Electronic Medical Records in Mental Health Settings: Scoping Review

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Abstract

Background: The success of electronic medical records (EMRs) is dependent on implementation features, such as usability and fit with clinical processes. The use of EMRs in mental health settings brings additional and specific challenges owing to the personal, detailed, narrative, and exploratory nature of the assessment, diagnosis, and treatment in this field. Understanding the determinants of successful EMR implementation is imperative to guide the future design, implementation, and investment of EMRs in the mental health field.

Objective: We intended to explore evidence on effective EMR implementation for mental health settings and provide recommendations to support the design, adoption, usability, and outcomes.

Methods: The scoping review combined two search strategies that focused on clinician-facing EMRs, one for primary studies in mental health settings and one for reviews of peer-reviewed literature in any health setting. Three databases (Medline, EMBASE, and PsycINFO) were searched from January 2010 to June 2020 using keywords to describe EMRs, settings, and impacts. The Proctor framework for implementation outcomes was used to guide data extraction and synthesis. Constructs in this framework include adoption, acceptability, appropriateness, feasibility, fidelity, cost, penetration, and sustainability. Quality assessment was conducted using a modified Hawker appraisal tool and the Joanna Briggs Institute Critical Appraisal Checklist for Systematic Reviews and Research Syntheses.

Results: This review included 23 studies, namely 12 primary studies in mental health settings and 11 reviews. Overall, the results suggested that adoption of EMRs was impacted by financial, technical, and organizational factors, as well as clinician perceptions of appropriateness and acceptability. EMRs were perceived as acceptable and appropriate by clinicians if the system did not interrupt workflow and improved documentation completeness and accuracy. Clinicians were more likely to value EMRs if they supported quality of care, were fit for purpose, did not interfere with the clinician-patient relationship, and were operated with readily available technical support. Evidence on the feasibility of the implemented EMRs was mixed; the primary studies and reviews found mixed impacts on documentation quality and time; one primary study found downward trends in adverse
Introduction

Information and information transfer are critical to the delivery of health care services, including in mental health settings [1]. Modern health care increasingly relies on new information technology (IT) systems to store, retrieve, and transfer information to support decision-making for care and administrative processes [2]. Among the health-related IT systems currently in use, electronic medical records (EMRs) are the most widely implemented across many settings [3]. In their simplest form, EMRs are digital versions of case histories containing patient health–related information, but they can also support artificial intelligence capabilities, clinical decision-support systems, natural language processing, and so on [4]. EMRs have the potential to improve adherence to clinical guidelines across all settings [5], thereby reducing resource wastage, increasing care quality, and reducing patient harm. Examples include improved prescribing practices and medication safety through integrated electronic ordering systems [6] and reductions in inappropriate laboratory testing because of integrated decision-support tools [7]. Ultimately, EMRs are expected to contribute to creating safer and more effective health systems [5].

Although several studies identifying the potential of EMRs have been published, evidence on their benefit to organizational, clinical, and patient outcomes after implementation continues to be mixed, with success appearing to be largely dependent on the design and fit with the local health care settings and workflows. For example, implementation of the same EMR system in two different university hospitals revealed that the time spent on documentation increased in one site but decreased in the other [8]. Furthermore, high-profile, unintended consequences because of EMR implementation by-products have been reported in recent times. A notable example includes the implementation of a £200 million EMR system in a major UK teaching hospital, leading to reduced performance and demoralized staff [9]. Poor usability of EMRs can impact quality of care and patient safety, as poor fit and design may cause fatigue, delayed case note entry, and adjacency errors [10]. As research on the implementation of EMRs continues to emerge, there is a strong need to understand the processes, systems, contexts, and human factors that influence successful implementation [11].

Although the adoption of EMRs has grown significantly in recent years, research that is specific to mental health settings or mental health clinicians has been minimal. Documentation in mental health settings brings unique challenges for the implementation of EMRs. Effective mental health documentation requires the recording of individualized, detailed, and narrative information, which is not easily reduced to checklists [12]. Care is often long term and multidisciplinary, requiring staff of different disciplines to record and retrieve information over long periods or in different settings (eg, hospital and community). Hence, the implementation of EMRs in mental health settings may have specific negative impacts, either real or perceived, on patient-centered care, the ability to develop the patient-clinician rapport, and on clinician time. Understanding the available evidence on implementation determinants and outcomes of EMRs in mental health settings, as well as the implementation features that contribute to its success or failure, could aid the future investment, design, and implementation of EMRs in this field.

The aim of this scoping review of the peer-reviewed literature was to provide a synthesis of implementation studies relevant to EMRs in mental health settings and inform EMR mental health policy recommendations in New South Wales, Australia. To provide in-depth recommendations, the review also considered broader evidence from general health settings to reflect on EMR implementation lessons. The specific objectives of this scoping review were to (1) identify published studies pertaining to the implementation of EMRs in mental health settings and literature reviews in general health settings, (2) synthesize the specific implementation determinants and outcomes examined in these studies according to the Proctor framework for implementation outcomes [13], and (3) provide local policy recommendations for future design and implementation of EMRs in mental health settings based on the findings.

Methods

Review Protocol

Our scoping review followed a predetermined (but unregistered) protocol that was developed in accordance with the PRISMA-ScR (Preferred Reporting Items of Systematic Review and Meta-Analyses Extension for Scoping Reviews) [14,15] and followed methods used in published peer-reviewed scoping reviews [16]. An exploratory search of 1 database over a 2-year period, conducted in consultation with a medical librarian and mental health experts on our team (GS and CT), confirmed that
the studies on EMRs implemented in mental health settings were limited. Therefore, in our scoping review, we also conducted a review of reviews to capture implementation literature across EMRs in all health settings and not just mental health, given that the broad issues around the usability of EMRs in general health settings are potentially relevant. The results of both search strategies were analyzed; for synthesis, we used a combination of results from primary studies and review papers.

In our scoping review, we defined mental health professionals as psychiatrists, psychologists, nurses, and any other health professional involved in treating people with mental health disorders in health service settings, including allied health professionals. These settings could be mental health clinics, or general inpatient or outpatient clinics but needed to be in high-income countries. High-income countries were classified as category 1 countries by the Organisation for Economic Co-operation and Development (OECD) [17]. This criterion was used to maintain relevance to the local policy setting context. Implementation determinants were defined as barriers and enablers that may prevent or facilitate improvements in practice [18], as reported in the included studies. The Proctor framework provides a systematic taxonomy of implementation outcomes (ie, acceptability, adoption, appropriateness, feasibility, fidelity, implementation cost, penetration, and sustainability), distinguishing these from service and patient outcomes [13].

**Search Strategy**

Our scoping review combined two systematic searches; the first captured published studies reporting primary data on the use and implementation of clinician-facing EMRs specifically in mental health settings (henceforth termed "primary studies"). The second search captured published reviews on the use of clinician-facing EMRs as implemented in all health settings irrespective of their relationship to mental health (henceforth termed "reviews"). The searches were conducted in three academic databases (MEDLINE via the PubMed Interface, EMBASE, and PsycINFO) and used the terms outlined in Table 1. Additionally, we manually searched the reference lists of the included studies (primary studies and reviews) for other relevant publications. All searches were limited to studies and reviews published between January 2010 and June 2020. The search strategies were devised by the review team with the assistance of an experienced medical librarian.

**Table 1. Database search strategy used in MEDLINE.**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Search terms for primary studies</th>
<th>Search terms for reviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMR-related terms</td>
<td>&quot;Electronic Health Records&quot;[MeSH] OR Medical Records Systems, Computerized [MeSH] OR (health record* OR medical record* OR healthcare record* OR health care record* OR clinical record*) AND (digital OR electronic OR computerized OR computerized OR ambulatory) [Title/Abstract]</td>
<td>&quot;Electronic Health Records&quot;[MeSH] OR Medical Records Systems, Computerized [MeSH] OR (health record* OR medical record* OR healthcare record* OR health care record* OR clinical record*) AND (digital OR electronic OR computerized OR computerized OR ambulatory) [Title/Abstract]</td>
</tr>
<tr>
<td>Health professional-related terms</td>
<td>Psychiatry&quot;[MeSH] OR &quot;Psychiatric Nursing&quot;[MeSH] OR (mental health OR psychiatric nurs* OR psychiatry OR psychiatrist OR psychology OR psychologist) [Title/Abstract]</td>
<td>Psychiatry&quot;[MeSH] OR &quot;Psychiatric Nursing&quot;[MeSH] OR &quot;Physicians&quot;[MeSH] OR &quot;Nurses&quot;[MeSH] OR &quot;Health Personnel&quot;[MeSH] OR (Physician OR nurse OR doctor OR psychiatrist OR psychologist OR health professional OR health personnel OR psychiatric nursing) [Title/Abstract]</td>
</tr>
<tr>
<td>Impact-related terms</td>
<td>(uptake OR adoption OR usability OR utility OR utilization OR utilization OR evaluate OR evaluation OR implementation OR acceptance OR acceptability) [Title/Abstract]</td>
<td>(uptake OR adoption OR usability OR utility OR utilization OR utilization OR evaluate OR evaluation OR implementation OR acceptance OR acceptability) [Title/Abstract]</td>
</tr>
<tr>
<td>Additional limiters</td>
<td>Published in English AND published between January 2010 and June 2020</td>
<td>(Systematic review or meta-analysis) AND published in English AND published between January 2010 and June 2020</td>
</tr>
</tbody>
</table>

EMR: electronic medical record.

Asterisk indicates truncation.

**Inclusion and Exclusion Criteria**

In both searches, articles were included if they met the following inclusion criteria: investigated implemented clinician-facing EMRs; conducted in high-income countries (countries classified as category 1 by the OECD [17]); assessed and reported implementation outcomes and contextual determinants of implementation (ie, barriers and facilitators); and published between January 1, 2010, and June 30, 2020. The population and study type inclusion criteria differed between the searches. The review of primary studies included studies related to mental health clinicians, whereas the review of reviews included literature reviews of studies about any health professionals in any health setting.

In both searches, articles were excluded if the implemented EMRs were exclusively patient-facing ones, they did not report on implementation processes or outcomes, or they were not published in English. The complete list of the inclusion and exclusion criteria is available in Multimedia Appendix 1.

**Screening, Data Extraction, and Synthesis Procedures**

Reference details, including abstracts, were downloaded into the reference management software EndNote X8 (Clarivate) [19]; duplicates were removed and the deduplicated list was...
exported to Rayyan QCRI [20], a systematic reviews web app, for title and abstract screening. Five investigators (HLT, LT, LAE, AG, and IM) independently conducted the two-phase screening process: (1) title and abstract screening and (2) full-text screening. Two investigators (HLT and IM) cross-checked 50% of the records to ensure that article screening was consistent in accordance with accepted practices [21]. Interrater reliability (Cohen kappa coefficient) in this cross-checking indicated strong agreement (>0.8) [22]. A custom data extraction workbook in Excel (Microsoft Corporation) was developed and tested. Data were systematically extracted by six investigators (HLT, LL, LT, AG, LAE, and IM). Four investigators (LT, LAE, YZ, and IM) examined the data for consistency and cross-checked the extracted data against original articles.

Key information extracted included the study publication details (authors, date of publication, country of study, and number of studies in reviews), health settings, study methods (quantitative, qualitative, and mixed methods), design features of EMRs, and implementation barriers, enablers, and outcomes. To ensure consistency in our review, the Proctor framework of implementation outcomes presented in Table 2 was used as the guiding structure, with definitions tailored to suit the EMR implementation context [13].

### Table 2. Proctor implementation outcomes as applied in this study.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adoption</td>
<td>Uptake of the EMR from the professionals, organizations, and settings</td>
</tr>
<tr>
<td>Acceptability</td>
<td>Clinician satisfaction with various aspects of the innovation (eg, content, complexity, comfort, delivery, and credibility)</td>
</tr>
<tr>
<td>Appropriateness</td>
<td>Perceived fit, relevance, compatibility, usefulness, and practicability defined by clinicians</td>
</tr>
<tr>
<td>Feasibility</td>
<td>Actual fit or usefulness, suitability for everyday use, and practicability assessed at the level of the health service provider/organization/setting</td>
</tr>
<tr>
<td>Fidelity</td>
<td>Program delivered as intended, adherence by clinicians, integrity, and quality of program delivery</td>
</tr>
<tr>
<td>Cost</td>
<td>Financial impact of technology implementation on the health provider or organization</td>
</tr>
<tr>
<td>Penetration</td>
<td>Spread or reach of the technology assessed at the organization or setting level</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Maintenance or integration of a technology within a health service</td>
</tr>
</tbody>
</table>

aEMR: electronic medical record.

### Assessment of Evidence Quality

Primary studies were appraised for quality using a modified Hawker appraisal tool and scoring system [23,24]. This tool was selected as it is designed to review evidence from a variety of methods [23]. The Critical Appraisal Checklist for Systematic Reviews and Research Syntheses developed by the Joanna Briggs Institute was used to appraise the systematic review studies [25]. Two investigators (HLT and IM) appraised 10% of the articles independently to ensure consistency. Quality assessment results were reported to reflect the quality of the studies and reviews included in our scoping review. We did not exclude studies based on quality assessment.

### Data Analysis and Synthesis

The extracted data were analyzed for common features and summarized into tables. Implementation outcomes were grouped by outcomes (eg, satisfaction), and barriers and enablers were grouped by themes (eg, technical factors). Barriers, enablers, and implementation outcomes were also categorized using the Proctor framework (Table 2), while recognizing some degree of overlap among constructs as suggested by other publications [13,26]. Assignments to the constructs were based on the definitions applied by the review team (Table 2) rather than the assignment made by the authors of the included articles owing to inconsistencies in the manner of defining, measuring, and reporting implementation outcomes [13]. Three investigators (YZ, LAE, and IM) reviewed the assignment of all the results, and any discrepancies were discussed among the three authors until a consensus was reached. Summary statistics (frequencies and proportions) were calculated for the final assignment.

### Results

#### Search Results and Study Selection

The search for primary studies yielded 1546 results relevant to mental health professionals or settings (Medline: 606; EMBASE: 620; PsycINFO: 320). Manually searching the article reference lists yielded 2 more papers. Among these, 271 duplicates were removed; after title/abstract screening, 1209 papers were excluded because they did not meet the inclusion and exclusion criteria. Furthermore, 68 studies underwent full-text review, and another 56 papers were excluded. We included 12 primary studies for data extraction and synthesis, as shown in Figure 1.
The search for reviews yielded 484 results (Medline: 175; EMBASE: 297; PsycINFO: 12). We identified 4 additional papers by manually searching article reference lists. Then, 73 duplicates were removed, and after title and abstract screening, 377 papers were excluded. Another 27 were excluded after full-text review, and 11 were included for data extraction and synthesis (Figure 1). A total of 23 studies were included for data extraction and synthesis from the 2 searches.

Half of the primary studies (6/12, 50%) were from the United States of America. The remaining primary studies were from Canada (2/12, 16.7%), the United Kingdom (2/12, 16.7%), France (1/12, 8.3%), and Sweden (1/12, 8.3%), as shown in Table 3. Most primary studies were conducted using quantitative methodologies (5/12, 42%), and fewer studies were conducted using qualitative (3/12, 25%) or mixed (4/12, 33%) methodologies. Each of the review studies included publications from several countries; however, in each review, at least more than 50% of the countries were OECD nations, as observed in Table 4. Among these 11 review studies, 1 (9%) focused on mental health settings [27], and the remaining 10 (91%) involved general health settings.
Table 3. Summary of the included primary studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Setting</th>
<th>EMRa implemented</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyer et al [28]</td>
<td>France</td>
<td>Psychiatric hospital</td>
<td>Hospital EMR including coded data, unstructured text, and scanned paper documents</td>
<td>115 health professionals</td>
</tr>
<tr>
<td>Bruns et al [29]</td>
<td>United States</td>
<td>Mental health facilities</td>
<td>EMR with standardization of information, assessments, and diagnosis; facilitated a coordinated care plan, team communication, and routine reporting</td>
<td>34 wraparound care coordinators</td>
</tr>
<tr>
<td>Erlingsdóttir et al [30]</td>
<td>Sweden</td>
<td>Psychiatry services</td>
<td>Patient-accessible EMR</td>
<td>871 mental health professionals preimplementation; 699 postimplementation</td>
</tr>
<tr>
<td>Golberstein et al [31]</td>
<td>United States</td>
<td>Primary care clinics</td>
<td>EMR prompting specific mental health questions and enabling e-consult ordering with psychiatry</td>
<td>Primary care providers (457 in the first wave; 499 in the second) from 45 clinics</td>
</tr>
<tr>
<td>Jetelina et al [32]</td>
<td>United States</td>
<td>Primary care</td>
<td>EMR with referral pathways, screening tools (point-and-click tools, drop-down menus, auto calculators, and auto population of some fields), and tracking and documentation of clinical and social information and goal setting</td>
<td>6 community care clinics with a mix of primary care, and psychology and social work</td>
</tr>
<tr>
<td>Madden et al [33]</td>
<td>United States</td>
<td>Medical practice</td>
<td>Not specified</td>
<td>Health insurance plan members with depression (5140), bipolar disorder (462), and a control group (43,582)</td>
</tr>
<tr>
<td>Martin et al [34]</td>
<td>Canada</td>
<td>Psychiatric hospital</td>
<td>Not specified</td>
<td>24 nurses</td>
</tr>
<tr>
<td>Reyes-Portillo et al [35]</td>
<td>United States</td>
<td>Child and youth psychiatry clinic</td>
<td>Alert in existing EMR that triggered a safety plan when a suicidal ideation, a plan, or an attempt was recorded</td>
<td>40 mental health clinicians</td>
</tr>
<tr>
<td>Riahi et al [36]</td>
<td>Canada</td>
<td>Mental health facility</td>
<td>EMR containing closed-loop medication administration, assessment and screening tools, care plan, details of restraint and seclusion, clinical practice guidelines, and infection control details</td>
<td>1300 facility staff</td>
</tr>
<tr>
<td>Ser et al [37]</td>
<td>United Kingdom</td>
<td>Mental health hospitals</td>
<td>Interoperable EMR</td>
<td>33 hospital staff</td>
</tr>
<tr>
<td>Skelton et al [38]</td>
<td>United Kingdom</td>
<td>Older adult psychiatric inpatient ward</td>
<td>Out-of-hours handover built into existing EMR</td>
<td>10 doctors</td>
</tr>
<tr>
<td>Stanhope et al [39]</td>
<td>United States</td>
<td>Community mental health clinics</td>
<td>Delivering person-centered care in the context of different EMRs</td>
<td>31 clinical supervisors and 52 direct care staff</td>
</tr>
</tbody>
</table>

aEMR: electronic medical record.
Table 4. Summary of the included reviews.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country (number of studies)</th>
<th>Setting</th>
<th>EMR(^a) implemented</th>
<th>Included studies, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baumann et al [40]</td>
<td>United States (12), Australia (5), Germany (5), United Kingdom (1), Canada (1), Austria (1), Denmark (1), Greece (1), and France (1)</td>
<td>Academic, private, and community hospitals</td>
<td>Not specified</td>
<td>28</td>
</tr>
<tr>
<td>Boonstra et al [41]</td>
<td>United States (17), Canada (2), Norway (1), and Ireland (1)</td>
<td>General health settings</td>
<td>Not specified</td>
<td>22</td>
</tr>
<tr>
<td>Castillo et al [42]</td>
<td>United States (52), Canada (4), Australia (3), Germany (2), International group (1), Denmark (1), France (1), Sweden (1), Hong Kong (1), United Kingdom (1), and Norway (1)</td>
<td>General health settings</td>
<td>Not specified</td>
<td>68</td>
</tr>
<tr>
<td>Delardes et al [43]</td>
<td>United Kingdom (4), United States (3), Ireland (1), and Taiwan (1)</td>
<td>General health settings</td>
<td>Not specified</td>
<td>9</td>
</tr>
<tr>
<td>Gephart et al [44]</td>
<td>United States (4) and Sweden (1)</td>
<td>General health settings</td>
<td>Not specified</td>
<td>5</td>
</tr>
<tr>
<td>Goldstein et al [45]</td>
<td>United States (8), Austria (1), Brazil (1), Canada (1), and Switzerland (1)</td>
<td>General health settings</td>
<td>Not specified</td>
<td>12</td>
</tr>
<tr>
<td>Goldzweig et al [46]</td>
<td>United States (20), France (1), Canada (1), and Austria (1)</td>
<td>Academic medical centers</td>
<td>Classification of radiology ordering of EMR interventions into four categories: (1) display of information, (2) patients’ clinical information linked with recommendations, (3) soft stop if order contradicts recommendations, and (4) hard-stop software preventing inappropriate ordering</td>
<td>23</td>
</tr>
<tr>
<td>Lau et al [47]</td>
<td>United States (11), United Kingdom (10), the Netherlands (5), Canada (4), Australia (4), Norway (2), and New Zealand (2)</td>
<td>General health settings</td>
<td>Not specified</td>
<td>43</td>
</tr>
<tr>
<td>Meißner and Schnepp [48]</td>
<td>United States (4) and Australia (3)</td>
<td>Residential aged care facilities</td>
<td>Not specified</td>
<td>7</td>
</tr>
<tr>
<td>Nguyen et al [49]</td>
<td>United States (62), Denmark (5), England (5), Norway (4), Canada (3), Sweden (1), Australia (2), the Netherlands (2), Ireland (2), Israel (2), Austria (1), Cyprus (1), France (1), Serbia (1), Sweden (1), Japan (1), Korea (1), Kuwait (1), Cameroon (1), and Uganda (1)</td>
<td>General health settings</td>
<td>Not specified</td>
<td>98</td>
</tr>
<tr>
<td>Strudwick and Eyasu [27]</td>
<td>Germany (1), England (2), France (1), Finland (1), United States (1), and Sweden (1)</td>
<td>Mental health/ psychiatric clinic settings</td>
<td>Not specified</td>
<td>7</td>
</tr>
</tbody>
</table>

\(^a\)EMR: electronic medical record.

Quality Assessment

The primary studies scored highly on the modified Hawker appraisal tool [23], with an average score of 30.3 (SD 3.81) out of a possible score of 36. The reviews scored an average of 7.6 (SD 1.45) out of a possible score of 11 on the Joanna Briggs Institute Critical Appraisal Checklist for Systematic Reviews and Research Syntheses [25] (see Table S1 of Multimedia Appendix 2 for details).

Features of Implemented EMRs

The features of the EMRs were described in 8 of the 12 (66.7%) primary studies in mental health settings. Features ranged from the simple electronic storage of personal and health information...
documentation [28], e-ordering of consultations [31], and capability to enter free-text notes [30] to features that aimed to improve care quality including embedded assessment tools [32,35,36], and care coordination plans [29,32,38]. Specific examples included implementing automated alerts to develop safety plans for children and youth with suicidal ideations [35] and embedding an e-consultation pathway prompt linking primary health providers with a psychiatrist [31]. Overall, the description of EMR features was limited among the included studies. Four studies did not report on specific features; instead, they simply described the EMRs as storage of clinical notes and test results to improve the accuracy and completeness of clinical information [33,34,37,39]. Only 1 of the 11 (9.1%) reviews provided a comprehensive description of EMRs among the included studies [46] (Table 4).

### Implementation Outcomes and Determinants

#### Adoption

Adoption was reported in 10 of the 23 included studies (43.5%), namely 4 of the 12 primary studies (33.3%) [29,32,33,38] and 6 of the 11 reviews (54.5%) [27,41,42,45,48,49], as shown in Figure 2. Factors influencing the adoption of EMRs fell into three categories: organizational, technical, and financial.

First, in the primary studies, high adoption rates were attributed to organizational support and prioritization [29], strong leadership and buy-in, greater capacity and willingness to change, engagement of staff, and formal training [32]. In contrast, poor leadership and buy-in, high staff turnover, and poor capacity or unwillingness to change, resulted in lower adoption rates [32]. Two primary studies suggested that adoption was high without reflecting on the reasons for this [29,38]. Similarly, the reviews reported that organizational structure, readiness for change, participation of leaders and end users in planning and implementation, and support for end users impacted adoption [41,42,49]. Specifically, adoption was facilitated by training [49], larger facility sizes [41,45], clinical champions/leaders [41,49], and the removal of all paper-based notes [49]. A lack of clear implementation plans was identified as an important limitation to adoption [49].

In 6 of the 11 (54.5%) reviews, adoption was reported to be limited by the technological functions and design of EMRs such as perceived limited functionality [41,45,48,49], interoperability [41,42,45,49], lack of technical support, limited clinician technical skills (real or perceived) [27,41,42,45,49], insufficient hardware [41,45,49], and system failures (software or hardware breakdowns, errors, and need for frequent rebooting) [49]. None of the primary studies reflected on technological factors influencing adoption.

One review concluded that the start-up financial cost of EMRs were the second most common barrier to adoption, after technical issues [45]. Three other reviews also cited high start-up costs as a barrier to adoption [41,45,49]. None of the primary studies reported on cost factors influencing adoption.

#### Acceptability

Among the included studies, 2 out of the 12 primary studies (16.7%) [35,38] and 8 out of the 11 reviews (72.7%) [27,41,42,44-46,48,49] reported on clinician acceptance of (or satisfaction with) the implemented EMRs or aspects of EMRs (Figure 2). Reviews reported that positive clinician attitudes were necessary for successful adoption of EMRs [42,45,48].

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**Figure 2.** Implementation outcomes and determinants in primary studies and reviews.
However, clinician satisfaction with EMRs varied in primary studies and reviews.

One primary study found that mental health clinicians were neutral about the addition of an alert for a mental health safety plan in EMRs [35], whereas another found there were fewer complaints regarding the quality of clinical handover following the introduction of out-of-hours electronic handover systems in the EMRs [38].

In reviews, poor clinician satisfaction was associated with perceptions that the new software was complex, it took time to learn and use, and that time could be used for patient care [41,45,46,49]. There were also concerns regarding patient data privacy [27,41,44,45,48]. Rigidly designed EMRs and exclusion of end users from design processes [27,41,44], poor trust in the quality of EMR vendors [41], the perception that the software demanded excessive detail [49], and previous negative experiences or negative beliefs about the usefulness of EMRs were additional important barriers to acceptability [41,49]. Likewise, one review identified that high satisfaction was associated with the perceived reliability and usability of EMRs, and adequate support for end users [49].

**Appropriateness**

The perceived appropriateness of EMRs was reported in 7 of the 11 reviews (63.6%) and 8 of the 12 primary studies, as shown in Figure 2. Clinicians often assessed EMRs as appropriate or inappropriate based on their perceived impact on the clinical workflow and productivity, quality of clinical documentation, quality of care, and patient-clinician relationships.

In the primary studies, mental health clinicians perceived EMRs as appropriate when access to documentation improved [28], the time needed to send reminders to patients decreased [29], administration time decreased [29], and time was saved on documenting follow-up appointments owing to prefilled data [32]. On the other hand, mental health clinicians believed that EMRs lacked appropriateness when workflows were blocked or slowed [28], and when clinicians needed to take additional time to design workarounds for EMRs that did not meet their needs [37,39]. Similarly, in the reviews, EMRs reportedly lacked appropriateness when documentation time increased [41], at least temporarily [48], whereas other reviews found EMRs to be appropriate when access to documentation improved [27], and when there was minimal impact on documentation time [49]. One review further identified that although EMRs saved documentation time, the standard forms were not always appropriate for documenting assessments, treatments, and goals for patients receiving mental health care [27].

In the reviews, perceptions of improved documentation quality in terms of legibility, accuracy, completeness, and consistency were associated with clinicians’ views that EMRs were appropriate [44,48,49]. However, some clinicians in mental health settings [27,30] and in general health settings [44,49], believed that EMRs lacked appropriateness owing to the requirement of excessive or redundant information or when access to patient notes became a “watered-down” version of free-text clinical notes that lacked detail [30].

Across the primary studies and reviews, EMRs were perceived as appropriate if they were also perceived to be effective in terms of improving patient care [38] through supported decision-making based on availability of up-to-date information [30,31,48,49], better team communication, and averted potential medication errors [48,49].

One review suggested that EMRs improved patient-clinician interactions owing to the accessibility of information to clinicians [49]. Other reviews found EMRs that impacted decision-making processes and workflows left clinicians feeling devalued in their clinical role and were hence considered inappropriate [42,45]. No primary studies discussed the acceptability and impact of EMRs on the patient-clinician relationship.

**Feasibility**

Feasibility of the EMRs or EMR components was investigated in 5 out of the 12 primary studies (41.7%) [33-36,38] and 7 out of the 11 reviews (63.6%) [27,40,41,43,46,47,49] (Figure 2). Across all studies, the feasibility of implementation and use of EMRs by clinicians was assessed through proxies such as documentation outcomes (time taken and completeness), frequency of adverse events, quality of care, and face-to-face clinical time. These outcome measures differ from those used under adoption, acceptability, and appropriateness, as these include quantifiable impacts of the implemented EMRs or the actual fit for purpose rather than perceptions or opinions.

In the reviews, the measured impacts included improved documentation time, as mentioned in one review involving mental health settings [27], whereas others found no difference [40,41]. Documentation time was not quantified in any of the primary studies.

Completeness of documentation varied, with one review reporting increased completeness [49], whereas another found no impact [43]. In the primary studies, an alert system increased the number of completed mental health safety plans [36] and reduced the amount of missing data [34]. However, another primary study found that events (eg, emergency department and hospital visits or mental health diagnoses and related procedures) for mental health patients were less likely to be recorded in EMRs compared with other types of patients [33].

The impact on patient outcomes was rarely reported. A primary study found that an electronic handover system was associated with a downward trend in adverse events, but this was not statistically significant [38]. A review found that EMRs had no impact or had a small impact on adverse events such as hospital readmission [43].

Impacts of EMRs on care quality in mental health settings were not reported. However, reviews reported that EMRs reduced the time from orders to procedures [43], decreased medication errors [47], and improved appropriate ordering of radiographic tests, although they increased the number of missed tests [46].

**Cost**

None of the primary studies assessed the cost-effectiveness of EMRs. However, 4 of the 11 reviews identified that cost was a
barrier to adoption [41,42,49], and interoperability of EMRs could improve long-term costs [45]; there was no evidence that costs decreased owing to improved administrative effectiveness [49]. In addition, the ongoing costs of maintaining and upgrading EMRs were reported to be high and the return on investment uncertain [41].

**Fidelity, Penetration, and Sustainability**

These domains were seldom addressed across all the 23 included studies. One primary study reported improved patient-centered care, which was one of the intended impacts (fidelity) of that specific EMR system [39], and a review reported that the rate of EMR usage across clinical settings was exceedingly slow [49]. No study addressed the sustainability of the implemented EMRs.

**Discussion**

**Principal Findings**

In mental health settings, the adoption of EMRs is seemingly impacted by technical and organizational factors, as well as by clinician perceptions of appropriateness and acceptability. Clinicians perceived EMRs as acceptable and appropriate if they improved documentation completeness without interrupting workflow. Clinicians tend to value EMRs that support quality of care, are fit for purpose, have readily available technical support, and do not interfere with the clinician-patient relationship. Overall, the body of evidence specific to mental health was small. The implementation determinants and outcomes identified in general health settings aligned with and expanded on the mental health–specific findings. For example, the cost of implementation was identified as an additional barrier to adoption, apart from the technical and organizational factors identified in the mental health literature. However, evidence from general health settings did not consider the unique challenges of implementing EMRs in mental health settings. We have drawn on the evidence from general and mental health settings to make three recommendations for future implementation of EMRs in mental health settings.

Firstly, EMR implementation requires embedded long-term evaluation. In this review, we identified that approximately half of the studies focused on the early - to-middle stage implementation outcomes (ie, adoption, acceptability, appropriateness, and feasibility) [13], whereas later - stage implementation outcomes (ie, penetration and sustainability) [13] and implementation costs were rarely evaluated. Fidelity was assessed in only one primary study in a mental health setting. This is in contrast with the implementation research outside of research on EMRs, where implementation fidelity has more often been assessed compared with other outcomes [13]. This may be related to the nature of EMR technologies, which can be tailored and used flexibly to suit particular practices or service needs [50]. Sustainability was also not reported in any of the included studies, a finding that is consistent with implementation research outside of the EMR field where the assessment of program sustainability has been identified as a neglected area [13,51,52]. Limited research on the cost, fidelity, penetration, and sustainability of EMRs suggests limited evaluation and impact assessment, and the lack of long-term goal setting, particularly at the organizational level. We recommend that future implementation of EMRs in mental health settings must include continuous and embedded evaluation to explore long-term outcomes and impacts for health professionals and patients while identifying the determinants of cost, fidelity, penetration, and sustainability. Findings from thorough evaluations are needed to inform the future design, policies, and uptake of EMRs in mental health and other health settings.

Secondly, implementation of EMRs needs to adopt co-design principles and a human factors approach, including clinician participation in formative and summative usability testing prior to and during implementation [53,54]. The successful uptake of EMRs is influenced by clinicians’ perceptions of appropriateness and acceptability. In mental health settings, this was negatively impacted when EMRs misaligned with established workflows. It was also affected by organizational factors such as high staff turnover, low staff buy-in, and low capacity or willingness to change shown by clinicians. Evidence from general health settings suggests that these determinants can be modified by specific facilitating features such as staff training, clinical champions, buy-in from clinicians and leaders, IT support, and, above all, good fit for purpose with minimal disruption to clinical workflows. However, EMRs are commonly designed by IT professionals; although well intentioned, the software is often insufficiently flexible to meet the needs of clinicians at the frontlines of care [55]. Good fit with clinical workflows and local clinical contexts can be achieved through user-centered design processes and collaboration between clinicians and IT professionals [56,57]. Outside of this review and in general health settings, authors have recommended routine use of co-design principles and frameworks, formative evaluations in consultation with clinicians, and frameworks to assess the fit of off-the-shelf EMRs [58]. In the mental health–specific literature covered in this review, co-designing was not analyzed. In future, to enhance the fit of EMRs to the unique and sensitive clinical work undertaken in mental health, we recommend that the development and implementation of EMRs include co-design and formative evaluations to achieve an optimal fit to support usability for clinicians and patient centeredness.

Lastly, the implementation of EMRs needs to be guided by theories and frameworks to successfully navigate behavior change, and interactions between people and technology. In an environment where sensitive issues are addressed and building rapport and trust with patients is especially important, simply “injecting technology” is unlikely to yield better care, experience for health professionals, or successful implementation. For example, in this review, organizational factors such as leadership and culture were the common determinants of EMR implementation [32,41,42]. It is also likely that external factors (eg, health system structure, funding, and governance) impact EMR implementation as seen in other areas of mental health [59]; however, this was not addressed in the included studies. Successful implementation of EMRs requires structured methodology and careful planning, as changes in a social environment often require new skills and can have unpredictable impacts [60]. We recommend that the development, planning,
implementation, and evaluation of EMRs could be improved by applying appropriately structured guiding theories and frameworks (e.g., behavior change theory [61] or the normalization process theory [62]).

**Strengths and Limitations**

Despite a rigorous search strategy, it is possible that some potentially relevant studies were missed owing to a wide range of terms used to describe EMRs (e.g., health information systems and electronic health records). Nevertheless, our search strategy identified over 2000 potential publications across the two search strategies, reflecting its high level of comprehensiveness.

Further, the inconsistent use of implementation outcome terminologies across the literature and some degree of overlap among constructs as suggested by other publications [13,26] made it challenging at times to classify outcomes into the Proctor categories. Although this may have resulted in the misclassification of some findings, they were applied as closely as possible to the Proctor definitions. A robust process where classifications were reviewed by three of the authors (YZ, LAE, and IM) and any discrepancies were discussed until a consensus was reached is a methodological strength supporting our synthesis.

Lastly, although we assessed study quality using validated tools, owing to the limited evidence available, it was not feasible to exclude studies or distinguish findings based on quality. Quality assessment results are described in Table S2 of Multimedia Appendix 2.

**Conclusion**

The body of evidence about the implementation of EMRs in mental health settings is currently limited. Key enablers of the adoption of EMRs by clinicians in all health settings included clinician buy-in, staff training, IT support, and appropriate fit with the clinical context and workflows. Specific issues identified in mental health settings included limited suitability of the drop-down or checklist options and their impact on clinical workflows and patient–clinician interactions. Future implementation of EMRs could be facilitated through co-design with clinician end users, embedding routine implementation process evaluations, and including routine feedback from clinicians to facilitate adjustments and ensure usability and the best fit with the clinical context and person-centered care. Additionally, it is imperative that future implementations include embedded evaluations to assess long-term impacts on organizations, clinicians, and patients in mental health settings to inform future design, implementation, policy, and funding decisions. Lastly, the implementation of EMRs needs to recognize and address the interplay between the social factors and technical aspects of EMRs as a sociotechnical system to support successful uptake. Future research should consider the application of guiding social theories, implementation frameworks, and consistent use of terminology.

**Acknowledgments**

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**Authors’ Contributions**

This study was designed by YZ, LAE, CT, RCW, and GS. The search strategy was executed by HLT and IM. Data extraction and screening were conducted by YZ, LAE, HLT, LL, LT, and IM. Quality was assessed by HLT, LT, and IM. The extracted data were assessed for consistency by YZ, HLT, LAE, and IM. The first draft of the results section was written by IM, LAE, and HLT. The final draft was completed by YZ, LAE and IM with inputs from LL, RCW, LT, IM, CT, and GS.

**Conflicts of Interest**

None declared.

Multimedia Appendix 1
Inclusion and exclusion criteria.
[DOCX File, 17 KB - mental_v8i9e30564_app1.docx ]

Multimedia Appendix 2
Quality appraisal results of primary studies and reviews.
[DOCX File, 22 KB - mental_v8i9e30564_app2.docx ]

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Abbreviations

EMR: electronic medical record
IT: information technology
OECD: Organisation for Economic Co-operation and Development
Tablet-Based Cognitive Impairment Screening for Adults With HIV Seeking Clinical Care: Observational Study

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Abstract

Background: Neurological complications including cognitive impairment persist among people with HIV on antiretrovirals; however, cognitive screening is not routinely conducted in HIV clinics.

Objective: Our objective for this study was 3-fold: (1) to determine the feasibility of implementing an iPad-based cognitive impairment screener among adults seeking HIV care, (2) to examine the psychometric properties of the tool, and (3) to examine predictors of cognitive impairment using the tool.

Methods: A convenience sample of participants completed Brain Baseline Assessment of Cognition and Everyday Functioning (BRACE), which included (1) Trail Making Test Part A, measuring psychomotor speed; (2) Trail Making Test Part B, measuring set-shifting; (3) Stroop Color, measuring processing speed; and (4) the Visual–Spatial Learning Test. Global neuropsychological function was estimated as mean T score performance on the 4 outcomes. Impairment on each test or for the global mean was defined as a T score ≤ 40. Subgroups of participants repeated the tests 4 weeks or >6 months after completing the first test to evaluate intraperson test–retest reliability and practice effects (improvements in performance due to repeated test exposure). An additional subgroup completed a lengthier cognitive battery concurrently to assess validity. Relevant factors were abstracted from electronic medical records to examine predictors of global neuropsychological function.

Results: The study population consisted of 404 people with HIV (age: mean 53.6 years; race: 332/404, 82% Black; 34/404, 8% White, 10/404, 2% American Indian/Alaskan Native; 28/404, 7% other and 230/404, 58% male; 174/404, 42% female) of whom 99% (402/404) were on antiretroviral therapy. Participants completed BRACE in a mean of 12 minutes (SD 3.2), and impairment was demonstrated by 34% (136/404) on Trail Making Test A, 44% (177/404) on Trail Making Test B, 40% (161/404) on Stroop Color, and 17% (67/404) on Visual-Spatial Learning Test. Global impairment was demonstrated by 103 out of 404 (25%). Test–retest reliability for the subset of participants (n=26) repeating the measure at 4 weeks was 0.81 and for the subset of participants (n=67) repeating the measure almost 1 year later (days: median 294, IQR 50) was 0.63. There were no significant practice effects at either time point (P=.20 and P=.68, respectively). With respect for validity, the correlation between global impairment on the lengthier cognitive battery and BRACE was 0.63 (n=61; P<.001), with 84% sensitivity and 94% specificity to impairment on the lengthier cognitive battery.
Conclusions: We were able to successfully implement BRACE and estimate cognitive impairment burden in the context of routine clinic care. BRACE was also shown to have good psychometric properties. This easy-to-use tool in clinical settings may facilitate the care needs of people with HIV as cognitive impairment continues to remain a concern in people with HIV.

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KEYWORDS
cognitive complications; people with HIV; digital assessment; HIV; tablet; screening

Introduction

Thirty-six years into the HIV epidemic, North America has had markedly improved clinical outcomes and prolonged life. Death from non-AIDS comorbidities is now more common than AIDS-related death, and life-expectancy has increased markedly among those on antiretroviral therapy [1-5]. Similarly, AIDS-related comorbidities are now less common than noncommunicable, age-related comorbidities. Cognitive impairment among people with HIV persists despite effective antiretroviral therapy [6-9]. Cognitive impairment in the current treatment era is often mild and not readily detectable to the practicing clinician. At present, only clinical criteria and neuropsychological testing are used to diagnose cognitive impairment, and no single laboratory test or biomarker has been established to effectively detect mild cognitive impairment. Current screening measures (e.g., the International HIV Dementia Scale [10], Montreal Cognitive Assessment [11], HIV Dementia Scale [12]) lack sensitivity for detecting milder forms of cognitive impairment [13-18], and the resources (e.g., time, cost, training) required for comprehensive neuropsychological assessments limits their widespread use during routine clinic visits. Thus, there is a pressing need for brief screening measures that could be easily implemented into routine clinic care in order to determine persons in need of comprehensive neuropsychological evaluation.

Tablet computing tools, such as the Apple iPad, are increasingly ubiquitous and offer an opportunity to potentially implement an intuitive interface for primarily self-directed brief cognitive assessments with automated scoring, data aggregation, and preliminary screening of impairment in real time, thus minimizing clinician and staff burden and increasing the opportunity to identify individuals in need of neuropsychological evaluation. Recently, a brief iPad tool was developed to screen cognitive impairment. The testing platform has automated data aggregation, which provides global data to facilitate and or aggregate data. This study only relied on performance on the BRACE tests conducted in exam rooms with a research coordinator to help with administration (no staff monitoring). After completing the study visit, participants were added to our Clinical Research Management System data and was approved by the Johns Hopkins School of Medicine Institutional Review Board.

Study Population

From January 29, 2019 to December 30, 2019, a convenience sample of patients was recruited during routine clinic visits (via the clinic’s research desk or by provider referral) in the John G. Bartlett HIV Practice at the Johns Hopkins Hospital in Baltimore, Maryland. Inclusion criteria were minimal and only included (1) English-language proficiency and (2) being able to provide informed consent. There were no postconsent exclusion criteria because our goal was to determine feasibility of integrating BRACE in the context of routine clinic care for people with HIV rather than focus on HIV-associated neurocognitive disorders, which are only deemed present if the cognitive impairment cannot be attributed to any other comorbid condition or other confounders [19]. This study was conducted in accordance with ethical standards for human experimentation and was approved by the Johns Hopkins School of Medicine Institutional Review Board.

Procedure

Staff at the clinic’s research desk and providers directed interested patients to trained study research assistants. After confirming that patients met initial eligibility criteria, research assistants explained the study and obtained informed consent. Patients who enrolled completed the BRACE and the Computerized Adaptive Test for Mental Health. All visits were conducted in exam rooms with a research coordinator to help with administration (no staff monitoring). After completing the study visit, participants were added to our Clinical Research Management System to ensure that each patient only consented once to the study. Clinical Research Management System data entry was also important to identify when patients were due for their routine clinic visits. Due to the nature of the study, there was more flexibility in administration of follow-up visits (eg, follow-up completion of the BRACE occurred when participants’ clinic visits fell on or after the 6-month follow-up mark). This study only relied on performance on the BRACE at these visits. A subset of patients also completed a lengthier cognitive test battery as part of other ongoing neuroHIV clinical testing.
studies the same day as the completion of BRACE. The order of administration (BRACE before or after the lengthier battery) was based on patients’ schedules; we typically schedule our neuroHIV studies on the same day as clinic appointments.

### Cognitive Function Outcomes

This self-administered tool (automated audio and video instructions) used 4 validated neuropsychological tests.

The BRACE tool includes the Trail Making Test (TMT) Part A, which measures psychomotor speed, TMT Part B, which measures set-shifting and mental flexibility, Stroop Color Test, which measures processing speed, and Visual-Spatial Learning Test, which measures visuospatial learning and memory. BRACE has been shown to have high sensitivity to HIV-related or other brain dysfunction; during its development, T scores (mean 50, SD 10) were generated using a normative based regression approach (adjusted for age, sex, race/ethnicity, and education) based on a sample of 144 HIV-uninfected, healthy individuals free from significant confounds that might affect cognitive performance (eg, recent or significant traumatic brain injury, neurologic disorder, central nervous system infections, etc). The normative group was a mean age of 42.2 years (SD 15.7, range 18-70), with education level of 15.2 years (SD 2.26, range 9-20) with 45.8% being male and 56.9% White (T Marcotte, unpublished data). Six-month test–retest reliability (n=110) for the overall score was r=0.84. In an independent validation (T Marcotte, unpublished data) with 109 participants (66 people with HIV, 43 HIV-uninfected), a significant difference (P<.001) and a large effect size of 1.18 between the people with HIV and HIV-uninfected were found; the HIV-uninfected group had a mean T score of 50.8, suggesting the norms worked well when applied to this additional group.

A global neuropsychological score was computed by averaging performance across the 4 outcomes [9]. Impairment was defined as T score <40, based upon maximizing sensitivity and specificity relative to the full neuropsychological battery. The tool also includes an abbreviated version of the Patient’s Assessment of Own Functioning Inventory, a measure of self-reported cognitive complaints consisting of 5 dimensions, and the Patient Health Questionnaire–2, a measure inquiring about the frequency of depressed mood and anhedonia over the past 2 weeks. Significant self-reported cognitive symptoms were determined based upon regression-based analyses of the full Patient’s Assessment of Own Functioning Inventory. A score of 3 or greater on the Patient Health Questionnaire–2 was considered being at-risk for depression [20].

We retested BRACE in a subset of individuals within 30 days of initial testing (n=26) and more than 6 months after initial testing (n=67).

### Neuropsychological Test Battery

Within our study population, a subset of 61 participants also completed a lengthier cognitive test battery as part of other ongoing neuroHIV clinical studies on the same day that they completed BRACE. This subset was similar to rest of the study population on most factors except for sex, with the subsample having more women than the larger group had (Table S1 in Multimedia Appendix 1). The neuropsychological test battery included the following tests: (1) Hopkins Verbal Learning Test revised, which measures auditory-verbal learning and memory, (2) TMT Parts A and B, (3) Grooved Pegboard Test, which measures fine motor speed and dexterity, (4) Digit Symbol Modalities Test, which measures processing speed, and (5) Animal Fluency, which measures semantic verbal fluency. The completion order of the neuropsychological test battery and BRACE was not systematically assigned or tracked; some participants went from a routine clinical visit to a neuroHIV clinical study visit or vice versa. All outcome measures from these tests were standardized using regression-based equations from HIV-uninfected individuals participating in the Women’s Interagency HIV Study and the Multicenter AIDS Cohort Study [21,22]. Thus, all outcomes were in z score units (mean 0, SD 1). A global neuropsychological function score was computed by averaging all outcome measures. Impairment was defined a priori as performing 1 SD below the global neuropsychological mean [9].

### Covariates: Demographic Characteristics, HIV Biomarkers, Antiretroviral Therapy Medication, and Comorbidities

Patient-level variables were extracted and validated by 2 research coordinators. Sociodemographic factors included age, sex, race/ethnicity, and years of education. HIV-related clinical factors included the closest (until or on the day of assessment) plasma CD4 count and HIV RNA (lower limit of detection: 20 copies per mL) in the electronic medical record, and antiretroviral therapy medications (name and class of medication).

Additionally, we focused on extracting medical comorbidities within 4 general International Statistical Classification of Diseases and Related Health Problems (ICD-10) categories in the electronic medical record: (1) endocrine, nutritional, and metabolic diseases (ICD-10 codes E00-E99); (2) mental, behavioral, and neurodevelopmental disorders including substance use disorders (ICD-10 codes F01-F99); (3) nervous system disorders (ICD-10 codes G00-G99); and (4) circulatory system issues (ICD-10 codes I00-I99). These problems were selected as our focus as these comorbidities have known associations with cognitive health in HIV [23-26].

### Statistical Analysis

Descriptive statistics were used to characterize the study population and the prevalence of cognitive impairment. Pearson correlations were used to examine the association between performance on the BRACE initially and at a subsequent time point. Practice effects (performance initially vs a subsequent time point) were examined using a paired-sample t test. Pearson correlations were also used to examine the association between performance on BRACE and performance on the lengthier neuropsychological test battery. Logistic regression models were used to explore the univariable and multivariable associations of the covariates with the outcomes. Covariates included in the multivariable logistic regression models included those with a statistically significant univariable association and demographic characteristics with face validity, including age, sex, race/ethnicity, and HIV acquisition risk group. All analyses
were conducted in SAS software (version 9.4; SAS Institute Inc), and a \( P \) value < .05 indicated statistical significance.

**Results**

**Participant Characteristics**

The study population included 404 people with HIV (Table 1; age: range 21.6 to 79.3 years). Of the population, 99.5% (402/404) were currently on antiretroviral therapy, and 66.1% (267/404) had an undetectable viral load (<20 copies per mL) near the time of cognitive impairment assessment (median 10 days, IQR 63). The median CD4 level was 631 cells/μL (IQR 476) near the time of cognitive assessment (median 31 days, IQR 63). The most commonly prescribed antiretroviral therapy agents included nucleoside reverse-transcriptase inhibitors emtricitabine (258/404, 63.9%) and tenofovir alafenamide (245/404, 60.6%), protease inhibitor darunavir (94/404, 23.3%), and integrase inhibitors dolutegravir (170/404, 42.1%) and bictegravir (92/404, 22.8%).

Table 2 provides the most common (>5%) ICD-10 problems listed under 4 categories of comorbidities (endocrine, nutritional, and metabolic diseases; mental, behavioral, and neurodevelopmental disorders and substance use disorders; nervous system disorders; circulatory system issues).

On the iPad, 18.1% (73/404) had Patient Health Questionnaire-2 scores suggesting possible risk for depression, and 66.1% (267/404) perceived significant impairments in daily activities.
Table 1. Sociodemographic, behavioral, and clinical characteristics in the overall sample of people with HIV seeking clinical care and by cognitive impairment status based upon Brain Baseline Assessment of Cognition and Everyday Functioning performance.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall (N=404)</th>
<th>Impaired (n=103)</th>
<th>Not impaired (n=301)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>53.6 (10.7)</td>
<td>50.2 (10.5)</td>
<td>54.8 (10.5)</td>
<td>.001</td>
</tr>
<tr>
<td>Age &gt;50 years, n (%)</td>
<td>290 (71.8)</td>
<td>64 (62.1)</td>
<td>226 (75.1)</td>
<td>.01</td>
</tr>
<tr>
<td>Age &gt;60 years, n (%)</td>
<td>123 (30.4)</td>
<td>13 (12.6)</td>
<td>110 (36.5)</td>
<td>.001</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>230 (56.9)</td>
<td>63 (61.2)</td>
<td>167 (55.5)</td>
<td>.31</td>
</tr>
<tr>
<td><strong>Education</strong>, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>.97</td>
</tr>
<tr>
<td>Less than high school</td>
<td>119 (29.5)</td>
<td>30 (29.1)</td>
<td>89 (29.6)</td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>172 (42.6)</td>
<td>44 (42.7)</td>
<td>128 (42.5)</td>
<td></td>
</tr>
<tr>
<td>More than high school</td>
<td>111 (27.5)</td>
<td>27 (26.2)</td>
<td>84 (27.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Race</strong>, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>.36</td>
</tr>
<tr>
<td>African-American/Black</td>
<td>332 (82.2)</td>
<td>81 (78.6)</td>
<td>251 (83.4)</td>
<td></td>
</tr>
<tr>
<td>Caucasian/White</td>
<td>34 (8.4)</td>
<td>8 (7.8)</td>
<td>26 (8.6)</td>
<td></td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>10 (2.5)</td>
<td>3 (2.9)</td>
<td>7 (2.3)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>28 (6.9)</td>
<td>11 (10.7)</td>
<td>17 (5.6)</td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino ethnicity, n (%)</td>
<td>12 (3.0)</td>
<td>7 (6.8)</td>
<td>5 (1.7)</td>
<td>.008</td>
</tr>
<tr>
<td><strong>Current CD4 count</strong>, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>.24</td>
</tr>
<tr>
<td>Less than 200</td>
<td>43 (10.6)</td>
<td>15 (14.6)</td>
<td>28 (9.3)</td>
<td></td>
</tr>
<tr>
<td>200-500</td>
<td>91 (22.5)</td>
<td>24 (23.3)</td>
<td>67 (22.3)</td>
<td></td>
</tr>
<tr>
<td>More than 500</td>
<td>264 (65.3)</td>
<td>61 (59.2)</td>
<td>203 (67.4)</td>
<td></td>
</tr>
<tr>
<td><strong>Current HIV RNA (copies per milliliter)</strong>, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>.43</td>
</tr>
<tr>
<td>Undetectable (&lt;20)</td>
<td>266 (65.8)</td>
<td>62 (60.2)</td>
<td>204 (67.8)</td>
<td></td>
</tr>
<tr>
<td>Less than 200</td>
<td>83 (20.5)</td>
<td>26 (25.2)</td>
<td>57 (18.9)</td>
<td></td>
</tr>
<tr>
<td>Greater than 200</td>
<td>49 (12.1)</td>
<td>12 (11.7)</td>
<td>37 (12.3)</td>
<td></td>
</tr>
<tr>
<td>On antiretroviral therapy, n (%)</td>
<td>402 (99.5)</td>
<td>103 (100)</td>
<td>299 (99.3)</td>
<td>.41</td>
</tr>
<tr>
<td>On antiretroviral therapy and undetectable HIV RNA, n (%)</td>
<td>265 (65.6)</td>
<td>62 (60.2)</td>
<td>203 (67.4)</td>
<td>.18</td>
</tr>
<tr>
<td><strong>Nucleoside reverse-transcriptase inhibitor, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emtricitabine</td>
<td>258 (63.9)</td>
<td>67 (65.0)</td>
<td>191 (63.5)</td>
<td>.77</td>
</tr>
<tr>
<td>Tenofovir alafenamide</td>
<td>245 (60.6)</td>
<td>64 (62.1)</td>
<td>181 (60.1)</td>
<td>.72</td>
</tr>
<tr>
<td>Abacavir</td>
<td>82 (20.3)</td>
<td>21 (20.4)</td>
<td>61 (20.3)</td>
<td>.98</td>
</tr>
<tr>
<td>Lamivudine</td>
<td>77 (19.1)</td>
<td>19 (18.4)</td>
<td>58 (19.3)</td>
<td>.85</td>
</tr>
<tr>
<td><strong>Nonnucleoside reverse-transcriptase inhibitor, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rilpivirine</td>
<td>39 (9.7)</td>
<td>8 (7.8)</td>
<td>31 (10.3)</td>
<td>.45</td>
</tr>
<tr>
<td><strong>Protease inhibitor, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darunavir</td>
<td>94 (23.3)</td>
<td>25 (24.3)</td>
<td>69 (22.9)</td>
<td>.78</td>
</tr>
<tr>
<td>Ritonavir</td>
<td>44 (10.9)</td>
<td>10 (9.7)</td>
<td>34 (11.3)</td>
<td>.65</td>
</tr>
<tr>
<td><strong>Integrase inhibitor, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolutegravir</td>
<td>170 (42.1)</td>
<td>46 (44.7)</td>
<td>124 (41.2)</td>
<td>.54</td>
</tr>
<tr>
<td>Bictegravir</td>
<td>92 (22.8)</td>
<td>25 (24.3)</td>
<td>67 (22.3)</td>
<td>.67</td>
</tr>
<tr>
<td>Elvitegravir</td>
<td>52 (12.9)</td>
<td>11 (10.7)</td>
<td>41 (13.6)</td>
<td>.44</td>
</tr>
<tr>
<td>Raltegravir</td>
<td>21 (5.2)</td>
<td>4 (3.9)</td>
<td>17 (5.6)</td>
<td>.49</td>
</tr>
</tbody>
</table>

\(^a^Data are missing from 2 participants.

\(^b^Data are missing from 4 participants; antiretroviral therapy included are agents used by more than 5% of the sample.
Table 2. Common ICD-10 codes from medical records in the overall sample of people with HIV seeking clinical care and by Brain Baseline Assessment of Cognition and Everyday Functioning cognitive impairment status.

<table>
<thead>
<tr>
<th>ICD-10a</th>
<th>Overall (N=404), N (%)</th>
<th>Impaired (n=103), n (%)</th>
<th>Normal (n=301), n (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endocrine, nutritional, and metabolic diseases (ICD-10 E00-E89)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metabolic disorders (ICD-10 E70-E88)</td>
<td>239 (59.2)</td>
<td>57 (55.3)</td>
<td>182 (60.5)</td>
<td>.36</td>
</tr>
<tr>
<td>Overweight, obesity and other hyperalimentation (ICD-10 E65-E68)</td>
<td>144 (35.6)</td>
<td>32 (31.1)</td>
<td>112 (37.2)</td>
<td>.26</td>
</tr>
<tr>
<td>Diabetes (ICD-10 E8-E13)</td>
<td>73 (18.1)</td>
<td>14 (13.6)</td>
<td>59 (19.6)</td>
<td>.17</td>
</tr>
<tr>
<td>Disorders of other endocrine glands (ICD-10 E20-E35)</td>
<td>71 (17.6)</td>
<td>17 (16.5)</td>
<td>54 (17.9)</td>
<td>.74</td>
</tr>
<tr>
<td>Mental, behavioral, and neurodevelopmental disorders (ICD-10 F00-F99)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mood [affective] disorders (ICD-10 F30-F39)</td>
<td>330 (81.7)</td>
<td>83 (80.6)</td>
<td>247 (82.1)</td>
<td>.74</td>
</tr>
<tr>
<td>Mental and behavioral disorders due to psychoactive substance use (F10-F19)</td>
<td>234 (57.9)</td>
<td>58 (56.3)</td>
<td>176 (58.5)</td>
<td>.70</td>
</tr>
<tr>
<td>Other psychoactive substance related disorders (ICD-10 F19)</td>
<td>222 (55.0)</td>
<td>53 (51.5)</td>
<td>169 (56.1)</td>
<td>.41</td>
</tr>
<tr>
<td>Nicotine dependence (ICD-10 F17)</td>
<td>117 (29.0)</td>
<td>31 (30.1)</td>
<td>86 (28.6)</td>
<td>.77</td>
</tr>
<tr>
<td>Alcohol related disorders (ICD-10 F10)</td>
<td>84 (20.8)</td>
<td>18 (17.5)</td>
<td>66 (21.9)</td>
<td>.34</td>
</tr>
<tr>
<td>Opioid (ICD-10 F11)</td>
<td>61 (15.1)</td>
<td>16 (15.5)</td>
<td>45 (15.0)</td>
<td>.88</td>
</tr>
<tr>
<td>Cocaine (ICD-10 F14)</td>
<td>63 (15.6)</td>
<td>19 (18.4)</td>
<td>44 (14.6)</td>
<td>.35</td>
</tr>
<tr>
<td>Cannabis (ICD-10 F12)</td>
<td>59 (14.6)</td>
<td>15 (14.6)</td>
<td>44 (14.6)</td>
<td>.99</td>
</tr>
<tr>
<td>Anxiety, dissociative, stress-related, somatoform (ICD-10 F40-F48)</td>
<td>15 (3.7)</td>
<td>2 (1.9)</td>
<td>13 (4.3)</td>
<td>.27</td>
</tr>
<tr>
<td>Psychosis (ICD-10 F20-F29)</td>
<td>64 (15.8)</td>
<td>11 (10.7)</td>
<td>53 (17.6)</td>
<td>.10</td>
</tr>
<tr>
<td>Diseases of the nervous system (ICD-10 G00-G99)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Episodic and paroxysmal disorders (ICD-10 G40-G47)</td>
<td>163 (40.3)</td>
<td>43 (41.7)</td>
<td>120 (39.9)</td>
<td>.74</td>
</tr>
<tr>
<td>Polyneuropathies and other disorders of the PNS (ICD-10 G60-G65)</td>
<td>82 (20.3)</td>
<td>22 (21.4)</td>
<td>60 (19.9)</td>
<td>.76</td>
</tr>
<tr>
<td>Nerve, nerve root and plexus disorder (ICD-10 G50-G59)</td>
<td>66 (16.3)</td>
<td>13 (12.6)</td>
<td>53 (17.6)</td>
<td>.24</td>
</tr>
<tr>
<td>Diseases of the circulatory system (ICD-10 I00-I99)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertensive diseases (ICD-10 I10-I16)</td>
<td>29 (7.2)</td>
<td>7 (6.8)</td>
<td>22 (7.3)</td>
<td>.86</td>
</tr>
<tr>
<td>Ischemic heart disease (ICD-10 I20-I25)</td>
<td>192 (47.5)</td>
<td>41 (39.8)</td>
<td>151 (50.2)</td>
<td>.07</td>
</tr>
<tr>
<td>Other forms of heart disease (ICD-10 I30-I55)</td>
<td>64 (15.8)</td>
<td>7 (6.8)</td>
<td>57 (18.9)</td>
<td>.004</td>
</tr>
<tr>
<td>Diseases of veins, lymphatic vessels and lymph nodes (ICD-10 I80-I89)</td>
<td>51 (12.6)</td>
<td>6 (5.8)</td>
<td>26 (8.6)</td>
<td>.36</td>
</tr>
<tr>
<td>Pulmonary heart disease and disease of pulmonary circulation (ICD-10 I26-I28)</td>
<td>40 (9.9)</td>
<td>8 (7.8)</td>
<td>32 (10.6)</td>
<td>.40</td>
</tr>
<tr>
<td>Disease of arteries, arterioles and capillaries (ICD-10 I70-I79)</td>
<td>33 (8.2)</td>
<td>5 (4.9)</td>
<td>28 (9.3)</td>
<td>.15</td>
</tr>
<tr>
<td>Cerebrovascular disease (ICD-10 I60-I69)</td>
<td>32 (7.9)</td>
<td>6 (5.8)</td>
<td>26 (8.6)</td>
<td>.36</td>
</tr>
</tbody>
</table>

aICD-10 International Statistical Classification of Diseases, tenth revision.

Cognitive Function in People With HIV Seeking Clinical Care

The mean completion time for BRACE for the older individuals in the study population was 12 minutes (SD 3.2). The average T score on TMT A was 44.9 (SD 10.7), TMT B was 42.4 (SD 9.3), Stroop was 43.2 (SD 10.5), Visual-Spatial Learning Test was 47.7 (SD 8.4), and global neuropsychological function was 44.6 (SD 7.2) (Figure 1 and Figure 2; Tables S2 and S3 in Multimedia Appendix 1). When using the definition of impairment of 1 SD below the mean (T score <40), 33.7% (136/404) were impaired on TMT A, 43.8% (177/404) on TMT B, 39.9% (161/404) on Stroop, 16.6% (67/404) on Visual-Spatial Learning Test, and 25.5% (103/404) on global neuropsychological function.
Figure 1. Performance on iPad cognitive assessment tool of people with HIV seeking clinical care. The red line indicates the mean, the grey shaded section indicates the score is in the range of impairment (T score <40); the dotted grey line is T score=35 (1.5 SD below the mean). TMT: Trail Making Test; VSLT: Visual Spatial Learning Test.

Figure 2. Percentage impairment in study population of people with HIV seeking clinical care. TMT: Trail Making Test; VSLT: Visual Spatial Learning Test.

Of the 404 participants, 26 completed BRACE 30 days later. Test–retest reliability for the subset of participants repeating the measure was 0.81 (Figure 3). There were no significant practice effects ($P=0.20$) as the global neuropsychological mean at the first assessment was 46.6 (SD 5.8) and that at the second assessment was 47.72 (SD 6.7). Of the 404 participants, 67 (16.6%) completed BRACE more than 6 months later (days: median 294 days, IQR 50). Test–retest reliability for the subset of participants repeating BRACE almost 1 year later was 0.63 (Figure 4). There were no significant practice effects ($P=0.68$) as the global neuropsychological mean at the first assessment was 43.9 (SD 6.2) and the second assessment was 44.1 (SD 5.9).
The correlation between the lengthier cognitive test battery and global neuropsychological function via the iPad-based assessment in the subgroup of 61 at the first visit was 0.634 ($P<.001$; Figure 5). This subgroup comprised significantly fewer males (14/61, 23.0%) than the larger sample (216/343, 63.0%, $P<.001$). When examining the degree to which the BRACE outcomes were correlated with the lengthier cognitive test battery outcomes, all associations were in the expected direction, with higher performance on BRACE outcomes correlated with higher performance on neuropsychological test battery outcomes.
BRACE also demonstrated good discriminant validity when differentiating between people with HIV with and without global neuropsychological impairment (using a $T$ score cutoff of 40) on the gold standard neuropsychological test battery (Figure 7). Using a $T$ score cutoff of 40 for global neuropsychological function on BRACE yielded 0.84 sensitivity and 0.94 specificity when compared to global neuropsychological impairment using gold standard neuropsychological tests.

**Figure 5.** Associations between global neuropsychological function assessed with the tool at the initial time point and global neuropsychological function assessed via the gold standard neuropsychological battery in 61 people with HIV.

![Figure 5](image1)

**Figure 6.** Correlation heatmap between the individual outcomes assessed with the tool and the gold standard neuropsychological test battery. ***$P<.001$; **$P<.01$; *$P<.05$. SDMT: Symbol Digit Modalities Test; DMT: Symbol Digit Modalities Test; TMT: Trial Making Test; HVLT: Hopkins Verbal Learning Test-Revised; SEMFLU: semantic fluency; GPEG-D: Grooved Pegboard dominant hand; GPEG-ND: Grooved Pegboard nondominant hand; VSLT: Visual Spatial Learning Test.

![Figure 6](image2)
Figure 7. Performance (T scores) on the Brain Baseline Assessment of Cognition and Everyday Functioning iPad cognitive assessment as a function of global neuropsychological impairment (normal vs impaired based on a z score <1) using the gold standard neuropsychological test battery in people with HIV. ***P<.001. TMT: Trail Making Test; VSLT: Visual Spatial Learning Test.

Predictors

People with HIV demonstrating global neuropsychological impairment using the 1 SD cutoff on the BRACE screen were similar to cognitively healthy people with HIV on the majority of sociodemographic, clinical, and behavioral characteristics (Tables 1, 2, and 3). However, individuals demonstrating global neuropsychological impairment were younger (P<.001), more likely to be Hispanic/Latino (P=.008), and less likely to have ischemic heart disease (P=.004). In a multivariable logistic regression model, both age (P=.03) and Hispanic/Latino ethnicity (P=.02) were the only significant predictors of global neuropsychological impairment.

Table 3. Unadjusted and adjusted odds of cognitive impairment (1 SD cutoff) on Brain Baseline Assessment of Cognition and Everyday Functioning for sociodemographic, clinical, and behavioral factors in the overall sample of people with HIV seeking clinical care.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Univariable analyses, OR&lt;sup&gt;a&lt;/sup&gt; (95% CI)</th>
<th>Multivariable analysis, OR&lt;sup&gt;a&lt;/sup&gt; (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than or equal to 50 years of age (vs less than 50 years of age)</td>
<td>0.54 (0.34-0.88)&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.56 (0.33-0.96)&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Female (vs male)</td>
<td>1.26 (0.80-1.99)</td>
<td>1.27 (0.76-2.12)</td>
</tr>
<tr>
<td>Less than high school (vs high school or more)</td>
<td>0.98 (0.60-1.60)</td>
<td>1.07 (0.62-1.85)</td>
</tr>
<tr>
<td>African-American/Black</td>
<td>1.36 (0.78-2.39)</td>
<td>1.03 (0.55-1.93)</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>4.32 (1.34-13.91)&lt;sup&gt;**&lt;/sup&gt;</td>
<td>4.31 (1.25-14.90)&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Current CD4 count fewer than 200 (vs &gt; 200)</td>
<td>1.72 (0.88-3.37)</td>
<td>1.65 (0.80-3.40)</td>
</tr>
<tr>
<td>On antiretroviral therapy+ undetectable current HIV RNA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.71 (.45-1.12)</td>
<td>0.86 (0.51-1.44)</td>
</tr>
</tbody>
</table>

ICD-10 codes (any vs none)

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Univariable analyses, OR (95% CI)</th>
<th>Multivariable analysis, OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endocrine, nutritional, and metabolic diseases</td>
<td>0.81 (0.52-1.27)</td>
<td>1.04 (0.62-1.74)</td>
</tr>
<tr>
<td>Mental, behavioral, and neurodevelopmental disorders</td>
<td>0.91 (0.51-1.61)</td>
<td>0.90 (0.49-1.65)</td>
</tr>
<tr>
<td>Diseases of the nervous system</td>
<td>1.08 (0.69-1.70)</td>
<td>1.10 (0.67-1.80)</td>
</tr>
<tr>
<td>Diseases of the circulatory system</td>
<td>0.64 (0.41-1.01)</td>
<td>0.87 (0.51-1.48)</td>
</tr>
</tbody>
</table>

<sup>a</sup>OR: odds ratio.

<sup>b</sup>2 cases were not on antiretroviral therapy and were undetectable.

<sup>*</sup>P<.05.

<sup>**</sup>P<.01.
Discussion

BRACE was developed to briefly screen for cognitive impairment, particularly mild impairment that is not readily detectable by the practicing clinician. In our sample of 404 adults with HIV seeking outpatient clinical care, we demonstrated that this brief, self-administered screener of cognitive impairment can be self-administered rather rapidly in clinic (approximately 7-10 minutes; slightly longer in older adults, approximately 12 minutes) during routine clinic visits. Important to note is that our sample comprised predominately older, African-American/Black individuals with low education and a high burden of mental and behavioral health disorders, hypertension, and metabolic disorders based on electronic medical record. Thus, one of the strengths of the tool is that it can be used in persons who are nonreaders or with low literacy; the tests are not literacy dependent as both written and verbal instructions (via video) are provided. Importantly, the tool has excellent test–retest reliability, no practice effects over a 30-day or a median of approximately 10 months, strongly correlates to a briefer cognitive test battery, and has good classification accuracy compared to the lengthier cognitive test battery, which required 20 to 30 minutes to complete.

The global burden of cognitive impairment in this population using the standard 1 SD cutpoint on BRACE was 25% (103/404) with varying estimates of impairment across each test (67/404, 16.6% to 177/404, 43.8%). Estimates of global neuropsychological impairment using BRACE are consistent with those in previous studies—7% to 60% of people with HIV demonstrated cognitive impairment via neuropsychological testing [6-9,27,28] or other tablet-based tools to assess cognitive impairment, such as NeuroScreen [29].

In addition to estimating the burden of cognitive impairment, our large sample size enabled us to also examine covariates and risk factors for global neuropsychological impairment. Relative to the number of factors extracted from medical records, very few of these factors were associated with global neuropsychological impairment. Some of the factors that emerged are well-established sociodemographic factors including age and ethnicity [30]. Age emerged as a significant predictor of global neuropsychological impairment with higher performance among older versus younger people with HIV (P=.03). While the types of factors relating to cognition were expected [26,31], the relationships were not always in the anticipated direction. For example, our finding global neuropsychological impairment was higher in younger compared to older people with HIV is counterintuitive. At present, we are uncertain as to why this pattern was present. However, this finding is hypothesis generating and suggests the importance of cognitively screening people before the age of 50 years. It also remains unclear as to why people with HIV with Hispanic ethnicity were more likely to be impaired (P=.03). The T scores were demographically corrected for race/ethnicity as well as adjusted for age, sex, and education; and the tests in BRACE are not literacy dependent as both written and verbal instructions (via video) are provided.

The prevalence of cognitive impairment detected in outpatient clinical care suggests the need for HIV services that incorporate routine, brief cognitive screening into patient management for numerous reasons. Detection of cognitive impairment is necessary to adequately manage patient care and potentially improve clinical outcomes because, in its severe form, impairment may impact everyday functioning including attending routine HIV clinic care, financial and medication management, driving, multitasking, and vocational functioning [30,32-34]. Continued cognitive screening also allows for the ability for early detection, management, and intervention of mild forms of cognitive impairment that may either progress or fluctuate over time. As the mechanisms underlying cognitive impairment are likely complex and multifactorial, routine cognitive screening is necessary at minimum to determine whether modifiable factors (eg, medications with anticholinergic burden or polypharmacy for comorbid conditions [35], antiretroviral therapy medications such as efavirenz [36] or dolutegravir-based regimens) can lead to impairment (although not seen in the present study) and thus remedied by the clinician. To accomplish routine cognitive screening, resources would need to be allocated to cognitive screening. For instance, iPads would be needed if BRACE were to be implemented in clinic. Clinicians would also need to be trained on the tool for examining the results and determining any subsequent recommendations. For instance, if individuals demonstrate impairment via cognitive screening, further neuropsychological evaluation by a trained professional (ie, neuropsychologist) should be recommended to better understand domain-specific impairment because there is significant heterogeneity in cognitive function in people with HIV [9,37,38]. Not all individuals demonstrate the same neuropsychological profile and different impairment profiles may result from different predictors or different mechanisms. Further evaluation is also necessary to determine whether impairment identified by BRACE may have been due to disinterest or poor engagement with testing or malingering for secondary gain (eg, disability).

There are a number of study limitations including the cross-sectional study design, which precludes any discussion of causality, as well as possible self-selection bias or lack of generalizability as participants voluntarily chose to enroll in this study. Our lack of an HIV seronegative, at-risk comparison group was also a major study drawback. An HIV-uninfected control group would have enabled the direct comparison of the prevalence of cognitive impairment using the BRACE in people with HIV seeking routine clinic care compared to an uninfected control group after adjusting for any relevant sociodemographic, behavioral, and clinical factors. As our primary interest was in the implementation of BRACE in the context of routine clinic HIV care and the prevalence estimates of cognitive impairment among these patients, we did not seek a control group. However, it is important that our cohort of people with HIV was standardized to an external group of HIV-uninfected individuals, which is standard practice in clinical neuropsychology. While our T scores were estimated using a normative based regression approach (adjusted for age, sex, race/ethnicity, and education; T Marcotte, unpublished data), follow-up scores were not adjusted for practice at this point as those regression equations are currently being developed. This is important as the lack of
a practice effect in people with HIV may suggest impairment. Furthermore, it is also important to note that our T scores were estimated based on a sample of only 144 HIV-uninfected individuals aged 18 to 70 years. Our sample ranged in age from 21.6 to 79.3 years, with 5 people with HIV over the age of 70 years. Larger samples of HIV-uninfected individuals, particularly those individuals over 70 years of age, will be collected to refine these demographic adjustments. It may also be possible to better refine the cutpoints that maximize sensitivity and specificity for impairment, using more robust regression models. That work, in various cohorts, is underway. Another limitation was that our smaller sample of people with HIV completing a lengthier cognitive battery comprised fewer males than the larger sample. This study provides the groundwork for additional studies examining the psychometric properties of BRACE. Additionally, our measurement of clinical and behavioral comorbidities from ICD-10 is not optimal, particularly, for mental health (eg, depression or anxiety) and substance use disorders, which can fluctuate with management. Electronic medical record extraction of conditions is also not always comprehensive although it can be a rich data source. Future studies will be needed to look more deeply at better measurements of comorbidities in conjunction with BRACE. Additionally, at this point, we were unable to assess important covariates in this study including polypharmacy, which has shown to be associated with increased cognitive impairment [35]. Generalizability at this point is also limited to a predominately low educated, African-American, older people with HIV seeking outpatient clinic care, which is an important understudied population. Determining the clinical utility of BRACE in other US populations and internationally is warranted.

To continue to address cognitive impairment moving forward, traditional neuropsychological assessments are necessary but are often not conducted due to feasibility of available neuropsychologists as they typically have long wait lists. Thus, many persons with milder but clinically relevant cognitive impairment go undetected and without intervention. Sensitive and rapidly obtainable metrics that are obtained continuously, ubiquitously, and proactively in real time such as BRACE (an expanded cognitive screener) are needed. Other technology-based tools that differ from BRACE (eg, length of assessment; administrator-assisted; computer, tablet, or phone-based) have also been developed or used to screen for cognitive impairment in HIV including NeuroScreen [29,39], the Computer Assessment of Mild Cognitive Impairment [40], and CogState [41]. The primary advantage of BRACE is that it was designed to be self-administered versus administrator-assisted. Rapid advancement of iPad-based technologies have increased our ability to effectively screen cognitive impairment in busy clinics where HIV providers have limited time to manage patients with multimorbidity (eg, multiple medical, psychiatric, and cognitive conditions) and polypharmacy (eg, multiple antiretroviral therapy and nonantiretroviral therapy drugs in use). In addition, ubiquitous access to the internet enables updating of norms and the real-time calculations of risks. BRACE appears to provide the field with an effective user- and clinician-friendly cognitive screener that has the potential to influence patient care for identifying cognitive impairment (eg, identify a patient that may have been missed or identified too late), tracking performance over time, and determining prediction models of cognitive impairment. The results of BRACE can also inform the neuropsychological assessments which can expand upon the initial screen. While larger, longitudinal studies across heterogeneous subgroups of people with HIV and HIV-uninfected individuals in primary care are needed, our study provides initial evidence for the utility of this tool in predominately African-American older people with HIV with low levels of education seeking outpatient clinic care.

Acknowledgments

Digital Artefacts LLC, in collaboration with University of California San Diego, developed an iPad-based cognitive screening measure called BRACE (Brain Baseline Assessment of Cognition and Everyday Functioning) supported by the National Institute of Mental Health (grant R42MH099964; principal investigators: JS and TM).

Conflicts of Interest

AB is a full-time employee of Digital Artefacts LLC. JC is a full-time employee of Abbvie Inc. KA is a consultant to the All of Us Research Program (National Institutes of Health) and is on the scientific advisory board of TrioHealth.

Multimedia Appendix 1
Supplementary tables.
[DOCX File, 33 KB - mental_v8i9e25660_app1.docx ]

References


Abbreviations

AIDS: acquired immunodeficiency syndrome  
BRACE: Brain Baseline Assessment of Cognition and Everyday Functioning  
HIV: human immunodeficiency virus  
ICD-10: International Statistical Classification of Disease, tenth revision  
TMT: Trail Making Test

Tablet-Based Cognitive Impairment Screening for Adults With HIV Seeking Clinical Care: Observational Study

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Investigating Mental Health Service User Opinions on Clinical Data Sharing: Qualitative Focus Group Study

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Abstract

Background: Sharing patient data can help drive scientific advances and improve patient care, but service users are concerned about how their data are used. When the National Health Service proposes to scrape general practitioner records, it is very important that we understand these concerns in some depth.

Objective: This study aims to investigate views of mental health service users on acceptable data sharing to provide clear recommendations for future data sharing systems.

Methods: A total of 4 focus groups with 4 member-checking groups were conducted via the internet between October 2020 and March 2021, with a total of 22 service users in the United Kingdom. Thematic analysis was used to identify the themes.

Results: Six main themes, with several subthemes were identified, such as the purpose of data sharing—for profit, public good, and continuation of care; discrimination through the misattribution of physical symptoms to mental health conditions (ie, diagnostic overshadowing) alongside the discrimination of individuals or groups within society (ie, institutional discrimination); safeguarding data by preserving anonymity and confidentiality, strengthening security measures, and holding organizations accountable; data accuracy and informed consent—increasing transparency about data use and choice; and incorporating service user involvement in system governance to provide insight and increase security.

Conclusions: This study extends the limited research on the views and concerns of mental health service users regarding acceptable data sharing. If adopted, the recommendations should improve the confidence of service users in sharing their data. The five recommendations include screening to ensure that data sharing benefits the public, providing service users with information about how their data are shared and what for, highlighting the existing safeguarding procedures, incorporating service user involvement, and developing tailored training for health care professionals to address issues of diagnostic overshadowing and inaccurate health records. Adopting such systems would aid in data sharing for legitimate interests that will benefit patients and the National Health Service.

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KEYWORDS
clinical data; data sharing; mental health data; service users; focus groups; mental health; digital health; health records
Introduction

Background

Patient-level clinical data are increasingly recognized as a valuable resource that can help drive scientific advances and innovations to improve patient care [1]. Global initiatives actively promote and enable data sharing, and in research, most funders mandate researchers to plan for sharing their data [2-4]. However, to facilitate responsible data sharing, we need to develop systems that work for all stakeholders, and mental health service users need to be central to these developments. We already know that people with depression, epilepsy, and multiple sclerosis all have concerns about how their data would and should be used in health services [5-9]; however, these have not been explored in depth, and we do not know what service users consider to be acceptable limits for sharing their data. As the National Health Service (NHS) currently plans to scrape data from general practitioner practices [10], any concerns are likely to affect the legitimacy of such actions and potentially undermine the trust of mental health service users.

The Academy of Medical Sciences published a report on harnessing NHS data for future health benefits together with a dialogue report of conversations with NHS patients and the public on data use [11,12]. One challenge that surfaced is the continued protection of privacy, a particular concern for mental health service users [13]. The report also highlighted the balance between maintaining confidence in safeguarding data and enabling appropriate access to data-driven technologies. Many principles of data sharing are important for patients and the public, but there is considerable sensitivity among those with mental health problems because of stigma and discrimination [14]. There were few such individuals in the data dialogue study [11], but even when these individuals were asked or when others commented on mental health case studies, more skepticism was exhibited.

A previous qualitative study that investigated the views of service users about sharing administrative data [15] found that participants were largely comfortable sharing health records, including sensitive mental health data, with organizations that they trust. Trust was contingent on high transparency (ie, clarity on how this information would be shared and used), service user autonomy (ie, the ability of service users to have a say in the sharing of their data), and adequate security (ie, guarantees that the data shared would be adequately protected). However, this was a very small study (N=8); therefore, the themes reported are not generally applicable to the mental health population because of the geographic, age, and size limitations of their sample [15].

Objectives

There are various accepted data sharing and use models that exist domestically and internationally, but the technological landscape for data to be shared, integrated, and analyzed is constantly evolving. Therefore, there is a clear need for the views of service users to be represented in the development and governance of future data storage and use systems. This study investigates service user views to demarcate the boundaries of acceptable data use and sharing and provide clear recommendations for future systems.

Methods

Design

This is a qualitative study with focus groups conducted virtually between October 15, 2020, and March 15, 2021, using a videoconferencing software (Microsoft Teams) because of COVID-19. Focus groups followed a topic guide that contained open questions on sharing clinical data and their views on how systems should be developed to ensure that future data sharing initiatives are ethical and efficient. Each focus group was also followed with a member-checking focus group [16], to view the initial data analysis.

Recruitment

Participants were eligible if they were aged at least 18 years and had experience using mental health services. Participants needed internet or phone access and were excluded if they were unable to provide informed consent. They were recruited through purposive sampling via existing patient involvement groups and a research register (Consent for Contact) held by the South London and Maudsley NHS Foundation Trust (SLaM).

Focus Groups

The topic guide was based on previous data sharing research [15] and was expanded to include other issues that became apparent with changes in technology. The guide explored what participants thought about different data sharing models; how participants felt about their clinical data being shared with other hospitals, universities, government organizations, and companies; specific concerns about data sharing; how data can be shared (eg, raw data or aggregated summary data); their boundaries for what information can be shared; and how their trust can be earned about how their data are shared.

Participants were provided with a summary paper outlining current data sharing systems to provide background to the topic (Multimedia Appendix 1). This was referred to and summarized at the start of each focus group to ensure that participants had the same baseline prerequisite knowledge. In brief, the summary sheet includes the following information:

1. NHS Digital’s Hospital Episode Statistics data, which contain more than 1 billion records of patient service attendances across hospitals commissioned by England’s NHS Clinical Commissioning Groups [17].
2. The Clinical Record Interactive Search (CRIS) system, which provides authorized researchers with regulated access to anonymized patient-level data that are extracted from the SLaM electronic clinical records system. CRIS was developed with service user input on data protection issues, and applications were reviewed by a CRIS oversight committee, chaired by a service user. All data remained within the NHS firewall [18,19].

We also discussed the following potential adaptations to the CRIS data sharing system:
1. Extending CRIS by amalgamating data with other NHS trusts to provide a larger database so we can ask more questions. The data would be anonymous, and access will be governed by a committee as in the SLaM CRIS system. In this model, the data are outside the NHS firewall.

2. Developing separate CRIS databases within each individual NHS trust. These data would also be anonymous and follow similar rules as that of the SLaM CRIS system; however, the data would still be accessible within the NHS firewall of each NHS trust.

Each focus group lasted up to 2 hours, and each member-checking group lasted up to 1 hour; they were all digitally recorded using Microsoft Teams, and the recordings were transcribed manually.

Procedure
The study was approved by the East of the Scotland Research Ethics Committee (ref. 20/ES/0004). Participants provided written informed consent and their self-reported clinical and demographic characteristics before each of the 2 focus groups. The first focus group discussed acceptable data sharing, which was then analyzed to identify relevant themes and construct an initial thematic map. The second member-checking group considered the thematic map and provided feedback as a check that service users agreed with the emerging themes. Participants were reimbursed for their participation, and researchers supported the participants’ well-being and welfare throughout the study.

Data Analysis
Data collection continued until we reached data saturation, which was established by a review of the summary findings from each focus group (Multimedia Appendix 2) [20]. We used thematic analysis, following the six stages prescribed by Braun and Clarke [21]:

- Stage 1: The focus group recordings were manually transcribed to facilitate data immersion, and the recordings were listened to multiple times to ensure accurate transcription.
- Stage 2: Two service user researchers independently coded the data using an inductive coding approach.
- Stage 3: Once the initial codes were developed, potential themes were identified by combining codes to produce thematic maps.
- Stage 4: These themes were reviewed to establish relevance to the research question and ensure that they were coherent and distinctive. Any themes that were not supported with sufficient data or deemed too discrete were discarded.
- Stage 5: Relevant themes were clearly defined and named and then combined into a final thematic map.
- Stage 6: Relevant extracts from the transcripts were chosen to illustrate each theme. NVivo 12 software (QSR International) was used to manage and code the data.

Results
Sample Characteristics
A total of 22 people aged between 21 and 74 years (mean 45.04, SD 16.29 years) participated. The majority were women (15/22, 68%), and we had a diverse sample with only 55% (12/22) White British. The remaining samples were White European, Asian or Asian British, Black or Black British, or mixed White and Black Caribbean. Of the total participants, 91% (20/22) were diagnosed with a mental health condition (eg, depression or anxiety) and 64% (14/22) were educated to the degree level. Approximately 68% (15/22) of the participants resided in London (Southeast England), and the remaining participants lived in different regions of England (eg, West Midlands, East Midlands, and Southwest England).

Themes
Overview
Each theme and subtheme included in the final thematic map was discussed in at least two of the 4 focus groups (Multimedia Appendix 2). Figure 1 illustrates a summary of the six main themes and 22 subthemes. Service users found some existing models acceptable (eg, SLaM’s CRIS system) [18] because service users were involved in their development. Despite accepting this model, there were conflicting opinions about pooling data across different NHS trusts versus each NHS trust establishing their own CRIS-style data sharing system. Service users were concerned about the impact on security and diagnostic overshadowing (ie, where health care professionals appeared to dismiss their physical illnesses when made aware of their mental health diagnosis [22]), if CRIS was extended across NHS trusts, but they recognized the benefit of continuity of care. We subsequently describe each theme in detail.
Purpose

Service users expressed that they felt uncomfortable with their data being shared with commercial companies that used this information for their own financial gain, that is, for profit:

The concept of selling people’s data to a company for profit is completely unacceptable. [Participant 21]

However, service users were comfortable sharing data that contributed to the public good, such as academic research:

I feel quite comfortable about researchers and letting universities access it because I feel like the intention is to see health trends and to do good. [Participant 3]

Although service users generally found data sharing within the NHS acceptable and in line with the public good narrative, they did acknowledge that there was some skepticism because of the increasing privatization. However, it could be argued that the skepticism was because of NHS privatization in general, rather than solely in the context of data sharing:

Because of all this privatization of the NHS, which is very concerning for most of us, I signed a petition last week, because 49 GP surgeries have been sold to an American health insurance company. So that to me is very concerning. [Participant 21]

The extent to which service users were comfortable with organizations having access to summary versus raw data (or aggregated vs patient-level data) was also dependent on the purpose. Generally, service users felt it was more appropriate for summary data only to be provided when data were shared for profit, but when data were shared to benefit the public, service users voiced that organizations should have access to raw data to maximize use:

I would prefer summary [data] because companies like Google - the more information they have, they exploit it. So, I would say a summary can still help them to do research if they need to. [Participant 4]

It was also felt that sharing data to facilitate continuity of care for patients in health care settings was acceptable and could improve the quality of care service users received:

I couldn’t agree more with what you just said for continuity purposes. For example, ...you end up in another city, then you would hope they have access to the medical information - know what drugs you are on and so on so they can treat you quickly and correctly. [Participant 2]

...data sharing is quite important in terms of improving services or reducing the amount of time you have to keep explaining to different people about who you are, what you are, what you’re doing. [Participant 9]

Service users suggested that extending CRIS and having data from different NHS trusts collated in one place could be beneficial for continuity of care in health care settings:

...if you’re accessing different hospitals and then there’s not an exchange of information, sometimes you can think there’s no continuity. [Participant 3]

Discrimination

Within health care settings, service users recounted experiencing diagnostic overshadowing:

I have been basically stigmatized and dismissed when attending A&E for physical health concerns because they saw my mental health diagnosis. So, often in that situation, I wish it worked separately. [Participant 2]
Service users believed that data sharing within health care settings could also be detrimental to the quality of care when discriminatory beliefs or actions were present. As a result, service users were more comfortable with their physical health data being shared than their mental health data:

People with mental health conditions generally get poorer physical health care as they are often not believed...so many of us with mental health histories would prefer clinicians who are treating our physical ailments not to know about our mental health. [Participant 13]

...there’s a discrepancy between physical health and mental health for me personally...I don’t really mind if somebody knew that I’d broken my leg, for example, but actually I would mind if somebody knew that I went to see a doctor about my mental health. [Participant 3]

Service users also voiced concerns that were centered on discrimination toward individuals or groups in society, that is, institutional discrimination. It was felt that data sharing could lead to people being scapegoated or restricted from doing or receiving certain things, given the historical discrimination (eg, with Romani and gay communities):

Well it [the data] could be used, I suppose to stigmatise people or to prevent people from having, for example, the benefits that they are entitled to... [Participant 1]

Research was done into lots of communities, not just the Jewish community; Romani communities and lots of other communities in which the purpose wasn’t for the benefit of science. It was to discriminate...so lots of Romani people today feel very reluctant about giving information because they’re scared about where it may go. [Participant 7]

**Accuracy**

Service users reported having inaccurate clinical records and the negative impact that this had on their quality of care:

I do worry of false information that is there, that might have been entered years ago and nobody ever bothered to check...because it’s simply inaccurate. [Participant 2]

To address this, service users wanted more transparency from health care professionals regarding the content of their clinical notes. They wanted the opportunity to view their records to check that the information was accurate and if it was found to be inaccurate, to either have this amended or their disagreement noted in their records:

I mean for me it’s even more important that I had chance to regularly look at that information and check that it’s the correct information. [Participant 1]

**Informed Consent**

It was felt that there needed to be more transparency from organizations about what the data were being used for:

I think that people need to feel that their data is being used correctly. So, I think that they have to be more open and say we will use your data for this... [Participant 19]

They also discussed the need to increase awareness among service users about the data sharing process, as not all service users were aware that their data could be shared this way:

...I think it’s really important that everybody, like every member of the public, knows that their data can be accessed because I didn’t personally know that a researcher could access it in that way until I was doing this. [Participant 3]

Furthermore, service users wanted to have a choice in the sharing of their data after being appropriately informed, including the option to opt out of data sharing if they were not comfortable:

Just give the choice to the patient to decide which information to give out. [Participant 10]

**Safeguarding**

This theme considers the importance of storing and sharing data securely. Service users discussed the need to maintain confidentiality, with more consideration of who has access to sensitive data and preserving service user anonymity when sharing data:

...there might be a few things that you really need to share with the GP or a professional to see why you’re feeling the way you’re feeling or what’s causing you the mental health issues or physical health issues, but you don’t really want anyone else to read certain parts. [Participant 9]

I think as long as it’s anonymized, that’s fine. [Participant 19]

Service users were concerned about the security of data systems and the increased risk to security with a larger data set. For this reason, there was some hesitancy about expanding the CRIS system to pool all the data from different NHS trusts into one place:

I think in general it’s best not to put all your eggs in one basket [with the third CRIS model] and there is more of a security risk from pulling everything together. It also makes it much more likely to be the target of an attack. [Participant 13]

...the bigger it gets, the more I trust that the data wouldn’t be secure. [Participant 17]

It was felt that organizations needed to be held accountable for adhering to safeguarding protocols; if these protocols were breached, organizations should be penalized, and service users should be appropriately compensated:

...very much falls on the organisations to be accountable for making sure that they are adhering to data protection, GDPR, data storage, data sensitivity. [Participant 9]

...it would have to be a significant compensation measure for a person who potentially could have their
lives ruined by a data leak and if that was in place, I’d probably feel a lot more trusting of it [data sharing], and more free with the idea of that going ahead. [Participant 18]

Service User Involvement

There was a particular emphasis on service users being involved in the governance of data sharing systems, as is currently the case within the CRIS data sharing model. Service users felt that there was a need for a service user perspective to provide invaluable insight and make people feel more secure in sharing their data:

I would want service users to be involved in some of that governance. [Participant 1]

When you talk about CRIS and how the data are protected, I think it’s wonderful that you’re using it chaired by a service user and service user input is very valid throughout the protection system. [Participant 14]

...in terms of an additional security measure, you’ve got a group of trusted people [service users] who decide on what to do with the request... [Participant 18]

Discussion

Principal Findings

Trust has again been identified as a key component to effective engagement in research and health care settings [23]. Service users were hesitant about sharing data with commercial companies as they were mistrustful of their intentions, which were largely believed to be unethical and purely for profit. Currently, there is a limited sharing of data to commercial companies directly [24], although some commercial companies do register potential customers as pharmaceutical companies and medical device services.

Service users felt more comfortable sharing sensitive data within the NHS and with academic institutions as they had more confidence that the information would be used for public benefit, which mirrors the existing literature [11,15]. However, they also mentioned that increasing NHS privatization was beginning to affect their trust [25,26].

Service user trust is contingent on high transparency and service user autonomy [15], which was mirrored in our data, especially choice in the sharing of their data after learning how it is to be used. The current plan for data scraping and sharing by the NHS is being rolled out quietly and with little publicity. Although this is not suspicious, the lack of transparency is likely to undermine the confidence and reduce the overall worth of the data if many people decide to opt out. We recommend that future systems incorporate comprehensive screening processes to ensure that data sharing between organizations benefits the public and provides service users with adequate information about how their data are shared, and what for, to enable them to make an informed choice.

This concept of transparency can also be applied to health care settings. Service users wanted health care professionals to be more transparent with them about the content of their clinical notes, to resolve concerns about inaccurate health care records. Solutions proposed by service users in our study included ensuring that information is double-checked with patients before entering it and allowing service users to frequently view their health care records and dispute inaccuracies. Transparent medical records enhance trust, improve relationships with professionals, and increase understanding of health information [27,28]; however, there are concerns about service users reacting negatively to their content because of misinterpretation or misunderstanding, which could result in mistrust of health care professionals [28]. For transparency to be effective, the information within health care records must be communicated effectively and understood by the service user. We recommend increasing the transparency of clinical records and developing bespoke training for health care professionals in clinical data input and the communication of clinical information.

Discrimination within health care settings can have a negative effect on people’s trust in the health care system [29]. Existing studies indicate heightened skepticism about data sharing among individuals with mental health problems [11]. This is because of the stigma and discrimination experienced by service users within health care settings, resulting in poorer quality health care for people with mental health difficulties [14,30]. The issue of diagnostic overshadowing is not a new problem for service users, and we found that our service users’ experiences were not dissimilar to the findings in existing literature [31-34]. Improving clinical health care skills and knowledge can increase competence, reduce symptom misattribution, and encourage staff to reflect on their attitudes to prevent diagnostic overshadowing [30]. As a result, we recommend tailored training for nonmental health professionals to develop these skills.

Our results support the existing literature that highlights security and protection of privacy as prominent service user concerns, with trust contingent on adequate security [11-13,15]. Service users expressed the need to establish effective safeguarding measures and hold organizations accountable for any breach. Perceptions of security and privacy are positively correlated with trust, and greater perceptions of trust increase the likelihood of information sharing [35]. We recommend providing service users with clear information on existing General Data Protection Regulation procedures that are in place to protect patient data and hold organizations accountable for any data breach. Using trusted research environments may also be another solution to address security concerns related to sharing patient-level data [36].

Service user involvement was identified as an important factor to consider when developing future data sharing systems because it made them feel more confident. Service users have reported more open attitudes and improved trust in research as a result of involvement [37]. We recommend involving service users in the governance of future data systems to ensure that they are prioritized.

In terms of future research, there is a need to understand the acceptable levels of pseudonymization of data, as it is not understood how much data would breach the high public expectations of privacy. As more data are likely to be collated,
for example, in the general practitioner records data scraping [10], information from reduced post codes, criminal records, and other data will affect the chance of patient identification. Although this may be acceptable for high levels of patient benefit, this should not go unchallenged or agreed upon by the public, especially those who use mental health services.

**Strengths and Limitations**

The web-based nature of the study could have excluded some participants who did not have access to the required technology or who lacked digital competency [38,39]. Most of the participants were women. Although the current literature does not suggest differences in views, it is possible that the views of men and those from more diverse backgrounds might have weighted them differently. However, through our remote recruitment and data collection, it was more convenient and flexible for service users to participate and allowed participation from service users in geographically dispersed locations [40]. Our sample also fulfilled qualitative sample size criteria (N=22) [20,41,42] and provided views across a wider age range.

**Implications and Conclusions**

This study extends the limited research available on service user views and concerns regarding acceptable data sharing and provides a foundation for further research. We make five main recommendations to build service user trust in data sharing: (1) comprehensive screening processes, (2) developing tailored training for health care professionals to tackle diagnostic overshadowing and inaccurate health records, (3) providing service users with adequate information, (4) highlighting existing safeguarding procedures, and (5) incorporating service user involvement.

Although the qualitative nature of this study allowed us to obtain rich and detailed data, we found it challenging to clearly determine service user preferences for specific data sharing models. Future research should focus on conducting discrete choice experiments to quantify service user preferences and conclusively determine what models service users deem more acceptable for clinical data sharing in the United Kingdom.

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**Authors' Contributions**

SJ and TW designed the study. All authors carried out the literature search. SJ and AA collected data. AA, CM, and SJ analyzed the data. AA, SJ, and TW wrote the manuscript.

**Conflicts of Interest**

None declared.

**Multimedia Appendix 1**

Summary sheet.

[DOCX File, 1154 KB - mental_v8i9e30596_app1.docx]

**Multimedia Appendix 2**

Saturation grid of themes and subthemes represented in focus groups.

[DOCX File, 26 KB - mental_v8i9e30596_app2.docx]

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Abbreviations

- CRIS: Clinical Record Interactive Search
- NHS: National Health Service
- SLaM: South London and Maudsley National Health Service Foundation Trust
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Original Paper

Characteristics of Dimensional Psychopathology in Suicidal Patients With Major Psychiatric Disorders and Its Association With the Length of Hospital Stay: Algorithm Validation Study

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Abstract

Background: Suicide has emerged as a serious concern for public health; however, only few studies have revealed the differences between major psychiatric disorders and suicide. Recent studies have attempted to quantify research domain criteria (RDoC) into numeric scores to systematically use them in computerized methods. The RDoC scores were used to reveal the characteristics of suicide and its association with major psychiatric disorders.

Objective: We intended to investigate the differences in the dimensional psychopathology among hospitalized suicidal patients and the association between the dimensional psychopathology of psychiatric disorders and length of hospital stay.

Methods: This retrospective study enrolled hospitalized suicidal patients diagnosed with major psychiatric disorders (depression, schizophrenia, and bipolar disorder) between January 2010 and December 2020 at a tertiary hospital in South Korea. The RDoC scores were calculated using the patients’ admission notes. To measure the differences between psychiatric disorder cohorts, analysis of variance and the Cochran Q test were conducted and post hoc analysis for RDoC domains was performed with the independent two-sample t test. A linear regression model was used to analyze the association between the RDoC scores and sociodemographic features and comorbidity index. To estimate the association between the RDoC scores and length of hospital stay, multiple logistic regression models were applied to each psychiatric disorder group.

Results: We retrieved 732 admissions for 571 patients (465 with depression, 73 with schizophrenia, and 33 with bipolar disorder). We found significant differences in the dimensional psychopathology according to the psychiatric disorders. The patient group with depression showed the highest negative RDoC domain scores. In the cognitive and social RDoC domains, the groups with schizophrenia and bipolar disorder scored higher than the group with depression. In the arousal RDoC domain, the depression and bipolar disorder groups scored higher than the group with schizophrenia. We identified significant associations between the RDoC scores and length of stay for the depression and bipolar disorder groups. The odds ratios (ORs) of the length of stay were increased because of the higher negative RDoC domain scores in the group with depression (OR 1.058, 95% CI 1.006-1.114) and decreased by higher arousal RDoC domain scores in the group with bipolar disorder (OR 0.537, 95% CI 0.285-0.815).

Conclusions: This study showed the association between the dimensional psychopathology of major psychiatric disorders related to suicide and the length of hospital stay and identified differences in the dimensional psychopathology of major psychiatric disorders. This may provide new perspectives for understanding suicidal patients.
Introduction

Background
The World Health Organization states that nearly 800,000 people die each year from suicide, one every 40 seconds [1]. Most patients who committed suicide had psychiatric disorders [2]. Among psychiatric disorders, schizophrenia and affective disorders demonstrate the highest risk for suicide [3], but few studies have examined the differences in the suicide-related features of psychiatric disorders [4].

Suicide attempts vary depending on the method, intent, and medical severity of the aftereffects [5]. The length of hospital stay is especially related to the outcome of a patient hospitalized for suicide attempts [3] with some studies stating that patients with longer admissions are at greater risk of postdischarge suicide [6]. Understanding the psychiatric features of patients who stay longer in the hospital might help reduce the length of stay and perhaps their postdischarge outcomes [7]. Several studies have explored the factors associated with the length of stay in suicidal patients, but the results have been inconsistent [8].

Meanwhile, the diagnosis of psychiatric patients so far has relied on categorical diagnostic systems. As the limitations of categorical diagnostic systems became increasingly apparent, the research domain criteria (RDoC) was introduced as an alternate nosology by the National Institute of Mental Health (NIMH) [9]. Natural language processing (NLP) was introduced as one of the ways to use RDoC, and hospital readmission could be predicted with RDoC domains extracted by NLP [10]. Thus, NLP can be used effectively to evaluate psychiatric notes as RDoC domains [11].

Objectives
In this study, we aimed to explore the differences in the RDoC domains extracted by NLP among patients with depression, schizophrenia, and bipolar disorder who were hospitalized for suicide attempts. We sought to determine whether narrative clinical notes could identify suicide-related features of each disorder. We also investigated how these domains were associated with the length of hospital stay and compared them for each disorder.

Methods

Data Collection
Clinical and sociodemographic data were extracted from the electronic health records of patients in the psychiatry inpatient unit at Ajou University Hospital in South Korea between 2010 and 2020. All patients received a Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV-TR or DSM-5 diagnosis from a trained psychiatrist [12,13]. Clinical data included diagnosis (ie, depression, schizophrenia, and bipolar disorder) at admission and chief complaints at admission such as suicide attempts, suicide planning, and suicidal ideations. Sociodemographic data included the age, sex, length of stay, past medical history, and Charlson Comorbidity Index (CCI) score. Admission notes on the patients were extracted for estimating the RDoC scores by NLP. The data were encoded using the Observational Medical Outcomes Partnership (OMOP) common data model (CDM) (version 5) of the [14] in combination with a deidentification procedure. The OMOP-CDM is maintained by the Observational Health Data Sciences and Informatics network, which provides tools to facilitate data analysis. This study was approved by the Ajou University Hospital Institutional Review Board (AJIRB-MED-MDB-21-151), and the requirement for informed consent was waived owing to the deidentification.

Calculation of RDoC Scores Using Narrative Clinical Text
McCoy et al [11] previously described a method for estimating RDoC scores from narrative text. In summary, the method evaluates a document using a predetermined set of terms belonging to a given research domain. This list of terms was developed through a group of clinical professionals, including the NIMH RDoC working group. The score can be calculated using a bag of words of the corpus and the count of predefined RDoC terms that appear in the document. For instance, if 10 terms comprise a predefined list and 2 appear in a document, the note would be assigned a score of 2/10 (20%). The list of terms predetermined by the NIMH RDoC working group is publicly available on the internet [11]. The patient admission notes in this study were written in English and Korean. The source texts were 33% in English and 67% in Korean, which were similar for each patient. However, important medical entities such as chief complaints, medical histories, medication prescriptions, and any other important descriptions that directly indicated the patients’ status are represented in English. Moreover, to minimize data loss in the corpus, we systematically translated the corpus into English that was generated by the googleLanguageR package of the R programming language (version 3.6.2) [15]. As a result, we were able to derive RDoC scores from the documents, regardless of the language, as shown in Figure 1.
Figure 1. Overall workflow of extracting research domain criteria scores using a natural language processing pipeline. Admission notes were extracted from the electronic health records of the patients with diagnosis (ie, depression, schizophrenia, and bipolar disorder) and chief complaints such as suicide attempts, suicide planning, and suicidal ideation. Admission notes were translated into English by Google translator. After preprocessing, the score was calculated using the count of the predefined research domain criteria terms that appeared in the document. RDoC: research domain criteria.

Study Design and Analysis

We conducted a retrospective cohort study to explore the differences in the RDoC domains extracted by NLP among patients with depression, schizophrenia, and bipolar disorder who were hospitalized for suicide attempts. We also investigated how these domains were associated with the length of hospital stay and compared them for each disorder. Baseline demographic and clinical data were expressed as numbers (%) for categorical variables and means (SDs) for continuous variables. Differences between psychiatric disorders were compared using analysis of variance (ANOVA) for continuous variables and Cochran Q tests for categorical variables. Post hoc analysis of the RDoC domains was conducted using independent two-sample t tests. Linear regression modeling with adjustments for the sex, age, and CCI was used to analyze five domains (positive valence, negative valence, cognitive systems, systems for social processes, and arousal/regulatory systems) of the RDoC in different sociodemographic profiles. For each psychiatric disorder, a multiple logistic regression model analyzing the sociodemographic variables and RDoC domains was used to identify the factors associated with the length of hospital stay. For a secondary analysis, a Cox regression model with adjustments for demographics and categorical diagnosis was used to identify each domain associated with the length of hospital stay without controlling the other four domains. As the Mental Health Promotion and Welfare Act in South Korea defines involuntary psychiatric admission within 3 days [16], hospitalization for more than 3 days indicates serious psychiatric problems. Owing to this policy, the distribution of the length of stay was also divided into less than 3 days and more than 3 days. For these reasons, we defined the length of stay as less than 3 days or more than 3 days. All analyses were performed using the R programming language (version 3.6.2, R Foundation for Statistical Computing) and the open-source R packages.

Results

The demographic and clinical characteristics of 732 admissions for 571 participants are shown in Table 1. No significant differences were observed in the age, length of stay, CCI, sex, and medical history between the three psychiatric disorder groups. Table 2 shows that significant differences are observed in the negative valence, cognitive systems, systems for social processes, and arousal/regulatory systems domains in more than two of the three psychiatric disorder groups. In the post hoc analysis of the RDoC domains in the three psychiatric disorders, negative valence was the highest in the depression group (P < .001), whereas cognitive systems were significantly higher in the schizophrenia group than in the depression group (P = .004) and in the bipolar disorder group than in the depression group (P < .001). Like cognitive systems, systems for social processes were significantly higher in the schizophrenia group and the bipolar disorder group than in the depression group (P < .001). Arousal/regulatory systems were significantly higher in the depression (P = .004) and bipolar disorder (P = .04) groups than in the schizophrenia group. Furthermore, the RDoC domains differed in their associations with sociodemographic variables given in Multimedia Appendix 1. Age was significantly associated with the RDoC domains. Patients with increased levels of arousal/regulatory systems were older, whereas patients with more systems for social processes were younger. Being male was also associated with increased levels of positive valence. On the other hand, CCI was not associated with any RDoC domain.
Table 1. Baseline characteristics of the patient groups (N=571).^a

<table>
<thead>
<tr>
<th>Patient characteristic</th>
<th>Depression (n=465)</th>
<th>Schizophrenia (n=73)</th>
<th>Bipolar disorder (n=33)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean (SD)</td>
<td>36.4 (18.3)</td>
<td>31.3 (15.3)</td>
<td>34.8 (14.7)</td>
<td>.11</td>
</tr>
<tr>
<td>Length of stay, mean (SD)</td>
<td>8.8 (9.5)</td>
<td>9.9 (13.2)</td>
<td>6.4 (5)</td>
<td>.89</td>
</tr>
<tr>
<td>Charlson Comorbidity Index, mean (SD)</td>
<td>0.3 (0.9)</td>
<td>0.1 (0.4)</td>
<td>0.1 (0.4)</td>
<td>.44</td>
</tr>
<tr>
<td>Sex: female, n (%)</td>
<td>293 (63)</td>
<td>39 (53.4)</td>
<td>22 (66.7)</td>
<td>.25</td>
</tr>
</tbody>
</table>

Medical history, n (%)

| Hypertensive disorder      | 62 (13.3)          | 5 (6.8)              | 4 (12.1)                | .30     |
| Diabetes mellitus          | 24 (5.2)           | 2 (2.7)              | 0 (0)                   | .28     |
| Ischemic stroke            | 4 (1.5)            | 0 (0)                | 0 (0)                   | .45     |
| Renal impairment           | 10 (2.2)           | 1 (1.4)              | 1 (3)                   | .85     |
| Pneumonia                  | 21 (4.5)           | 2 (2.7)              | 1 (3)                   | .74     |

^aANOVA for continuous variables and Cochran Q tests for categorical variables were performed.

Table 2. Comparisons of research domain criteria scores of patients in the three psychiatric disorders (N=571).^a

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Depression (n=465)</th>
<th>Schizophrenia (n=73)</th>
<th>Bipolar disorder (n=33)</th>
<th>P value</th>
<th>Post hoc (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive valence</td>
<td>0.112 (0.048)</td>
<td>0.108 (0.045)</td>
<td>0.098 (0.036)</td>
<td>.21</td>
<td></td>
</tr>
<tr>
<td>Negative valence</td>
<td>0.146 (0.052)</td>
<td>0.099 (0.041)</td>
<td>0.100 (0.037)</td>
<td>&lt;.001</td>
<td>Depression &gt; schizophrenia (&lt;.001) depression &gt; bipolar disorder (&lt;.001)</td>
</tr>
<tr>
<td>Cognitive systems</td>
<td>0.189 (0.096)</td>
<td>0.156 (0.092)</td>
<td>0.189 (0.096)</td>
<td>&lt;.001</td>
<td>Schizophrenia &gt; depression (.004) bipolar disorder &gt; depression (&lt;.001)</td>
</tr>
<tr>
<td>Systems for social processes</td>
<td>0.112 (0.081)</td>
<td>0.168 (0.091)</td>
<td>0.176 (0.099)</td>
<td>&lt;.001</td>
<td>Schizophrenia &gt; depression (&lt;.001) bipolar disorder &gt; depression (&lt;.001)</td>
</tr>
<tr>
<td>Arousal/regulatory systems</td>
<td>0.101 (0.059)</td>
<td>0.080 (0.051)</td>
<td>0.102 (0.044)</td>
<td>.02</td>
<td>Depression &gt; schizophrenia (.004) bipolar disorder &gt; schizophrenia (.04)</td>
</tr>
</tbody>
</table>

^aData were analyzed by ANOVA followed by independent two-sample t tests during post hoc analysis.

^bNot applicable.

Next, we examined the association between the RDoC domains extracted from the admission notes and length of hospital stay. Table 3 summarizes the results of each psychiatric disorder group. In the patient group with depression, patients who scored high in negative valence were at an increased risk of a longer length of stay (odds ratio [OR] 1.058, 95% CI 1.006-1.114). In the patient group with schizophrenia, the RDoC domains were not associated with the length of stay. In the patient group with bipolar disorder, patients who scored high in the arousal/regulatory systems were at a decreased risk of a longer length of stay (OR 0.537, 95% CI 0.285-0.815).

In the secondary analysis, compared to the primary analysis, which considered 3-day hiccups and other domains, the depression group similarly showed significant association with negative valence (Table S2 in Multimedia Appendix 1). Unlike in the primary analysis, a significant association was shown with the arousal/regulatory systems of the depression group. In the schizophrenia group, there were no significant associations as in the primary analysis. In the bipolar disorder group, unlike primary analysis, significant association was shown with positive valence.
Table 3. Regression model results of research domain criteria scores and length of hospital stay (N=732).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Depression (n=612)</th>
<th>OR (95% CI)</th>
<th>P value</th>
<th>Schizophrenia (n=83)</th>
<th>OR (95% CI)</th>
<th>P value</th>
<th>Bipolar disorder (n=37)</th>
<th>OR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive valence</td>
<td>0.975 (0.935-1.018)</td>
<td>0.25</td>
<td></td>
<td>1.016 (0.897-1.157)</td>
<td>.81</td>
<td></td>
<td>1.297 (0.938-1.973)</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td>Negative valence</td>
<td>1.058 (1.006-1.114)</td>
<td>0.03</td>
<td></td>
<td>1.090 (0.933-1.279)</td>
<td>.28</td>
<td></td>
<td>1.290 (0.967-1.860)</td>
<td>.11</td>
<td></td>
</tr>
<tr>
<td>Cognitive systems</td>
<td>1.01 (0.957-1.048)</td>
<td>0.96</td>
<td></td>
<td>1.087 (0.952-1.252)</td>
<td>.22</td>
<td></td>
<td>1.145 (0.887-1.561)</td>
<td>.33</td>
<td></td>
</tr>
<tr>
<td>Systems for social processes</td>
<td>1.010 (0.966-1.058)</td>
<td>0.66</td>
<td></td>
<td>0.959 (0.861-1.068)</td>
<td>.44</td>
<td></td>
<td>1.079 (0.881-1.361)</td>
<td>.47</td>
<td></td>
</tr>
<tr>
<td>Arousal/regulatory systems</td>
<td>0.957 (0.906-1.011)</td>
<td>0.11</td>
<td></td>
<td>0.901 (0.759-1.057)</td>
<td>.21</td>
<td></td>
<td>0.537 (0.285-0.815)</td>
<td>.02</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sociodemographic features</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.000 (0.989-1.012)</td>
<td>.95</td>
<td></td>
<td>1.010 (0.975-1.051)</td>
<td>.59</td>
<td></td>
<td>1.020 (0.936-1.125)</td>
<td>.66</td>
<td></td>
</tr>
<tr>
<td>Charlson Comorbidity Index</td>
<td>0.996 (0.789-1.295)</td>
<td>.98</td>
<td></td>
<td>1.391 (0.259-24.352)</td>
<td>.75</td>
<td></td>
<td>0.057 (0.000-1.924)</td>
<td>.49</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>0.943 (0.634-1.394)</td>
<td>.77</td>
<td></td>
<td>1.246 (0.419-3.708)</td>
<td>.69</td>
<td></td>
<td>0.402 (0.014-5.742)</td>
<td>.52</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Principal Findings

In this study, we identified statistically significant differences in the RDoC scores among psychiatric disorders and showed significant associations between the RDoC scores and length of stay for depression and bipolar disorder. The association between suicide and RDoC domains has been reported [17], but very few studies have analyzed how this relationship differs from disorder to disorder. In this regard, the present study investigated whether the RDoC scores derived by NLP differed for each disorder and whether they were related to clinical outcomes such as the length of hospital stay.

The depression group showed the highest negative valence scores among the disorder groups. Previous studies comparing the distribution of domains by diagnosis also showed differences in the negative valence scores for depression and bipolar disorder, and depression and schizophrenia [18]. Our findings not only confirm the previously established association between negative valence and suicide [19] but also suggest that negative valence is particularly associated with depression. Conversely, the schizophrenia and bipolar disorder groups scored higher than the depression group in the cognitive systems and systems for social processes, and no significant difference was found in the scores between the two groups. Several studies have suggested a significant overlap between schizophrenia and bipolar disorder [20], and similarities between these two disorders are prominent in cognitive and social functions [21,22]. Our results are in line with previous results and provide additional information that cognition and social function are important factors in suicide cases involving schizophrenia and bipolar disorder. In the arousal/regulatory systems, the bipolar disorder group scored significantly higher than the schizophrenia group, whereas no significant difference was found in the scores between the depression and bipolar disorder groups. Significant similarities in sleep features representing the arousal/regulatory systems between depression and bipolar disorder have been reported [23]. However, as schizophrenia and bipolar disorder are highly related to sleep disorders [24], it remains unclear whether the scores of the schizophrenia group in the arousal/regulatory systems are more significant than those of the bipolar disorder group.

In the current study, we found that negative valence scores were associated with a longer length of stay in the depression group (OR 1.058, 95% CI 1.006-1.114). The association found between negative valence and depression as well as suicide is consistent with previous findings [19,25]. In the schizophrenia group, no significant relationship was found between the RDoC domain and length of stay, whereas scores in the arousal/regulatory systems were associated with a shorter length of stay in the bipolar disorder group (OR 0.537, 95% CI 0.285-0.815). Contrary to our findings regarding bipolar disorder, a previous study has reported that higher arousal domain scores were
associated with a longer length of stay for bipolar disorder [11]. However, sleep disturbance varies with the bipolar disorder phase [26]. These findings show that further consideration of the bipolar disorder phase is needed in interpreting the arousal domain scores with respect to bipolar disorder. Although previous studies found a significant association between the RDoC domain and length of hospital stay, some inconsistencies in prior significant relationships have been identified. For example, one study reported that a positive domain was associated with a shorter stay; however, another showed that a positive domain was associated with a longer stay [11,27]. Thus, the relationship may vary depending on the specific cohort. The association between the length of stay and RDoC domain is unclear for schizophrenia and differs from previous studies with respect to bipolar disorder because our work not only had a cohort different from that of previous studies but also analyzed the relationship between the length of stay and specific disorders.

Our findings show significant associations between the RDoC domains and length of hospital stay for depression and bipolar disorder. This result is consistent with those in existing literature reporting that the estimated RDoC domain scores were associated with the length of stay [27]. Moreover, significant differences and trends in the RDoC domains among depression, schizophrenia, and bipolar disorder were demonstrated. These findings are consistent with those of previous studies on the relationship between negative valence scores and major depressive disorders [25]. Recent publications suggest that cognitive and social functioning factors were observed in schizophrenia and bipolar disorder but not in depression, which is consistent with our findings [28]. On the other hand, using NLP to calculate the RDoC scores is more useful than using structural data alone [11]. For example, the RDoC of the cognitive domain extracted by NLP facilitated stratification of risk for dementia [29]. Our findings further validate the usefulness and robustness of the RDoC scoring system, which identifies important clinical features in clinical notes. Furthermore, with this validated RDoC NLP tool, our study was conducted by integrating bilingual clinical notes into RDoC domains. Although prior research relied primarily on clinical notes written in English, our results show that the use of RDoC domains through NLP is appropriate for clinical notes that are not in English.

**Limitations**

Our study has a few limitations. First, even though we extracted database records of suicidal patients from 2010 to 2020, we could identify only 732 psychiatric admissions in 571 patients. To validate our findings more accurately, a large data set is required. Second, our study has analyzed the conditions most highly related to suicide, but other suicide-related conditions, such as substance use disorders and personality disorders, have not been considered. Because substance use disorders and personality disorders frequently coexist with depression, schizophrenia, and bipolar disorder [30], it was difficult to distinguish between the disorders. Third, the accuracy of the translation of Korean text into English was not evaluated because this was beyond the scope of this study. The accuracy and effectiveness of using clinical NLP algorithms on multilingual clinical documents should also be investigated and validated in future.

**Conclusions**

Our study showed that the estimates of dimensional psychopathology derived from NLP are associated with the length of hospital stay in suicidal patients with depression or bipolar disorder and vary significantly among suicidal patients with depression, schizophrenia, and bipolar disorder. Therefore, our findings suggest that more attention might be paid to negative valence for depression and arousal/regulatory systems for bipolar disorder in relation to suicide. Additionally, our results may increase the understanding of the differences in dimensional psychopathology among suicidal patients with depression, schizophrenia, and bipolar disorder. We hope that further investigations will clarify the differences in the RDoC scores of suicidal patients and associations between the RDoC scores of suicidal patients and clinical outcomes.

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**Authors' Contributions**

DYL and JP drafted the manuscript. JSN and HWR designed the study and critically reviewed the manuscript. RWP is primarily responsible for the final paper. JHH, EYL, and SJS provided critical opinions on the study design and manuscript. All authors have approved the final manuscript.

**Conflicts of Interest**

None declared.

**Multimedia Appendix 1**

Association between sociodemographic features and research domain criteria scores.

[DOCX File, 27 KB - mental_v819e30827_app1.docx ]
References


Abbreviations

ANOVA: analysis of variance
CCI: Charlson comorbidity index
CDM: common data model
DSM: Diagnostic and Statistical Manual of Mental Disorders
NIMH: National Institute of Mental Health
NLP: natural language processing
OMOP: Observational Medical Outcomes Partnership
OR: odds ratio
RDoC: research domain criteria

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