



Using Remote Patient Monitoring to Provide Data-driven Health Care

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Our Featured Speaker



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Dr Aungst is an associate professor of pharmacy practice at MCPHS in Worcester, MA. He is also a clinical pharmacist at a home health care agency, with a focus on chronic disease medication management.

Dr Aungst is a digital health advocate for the pharmacy space. His focus is on digital medicines and adherence development, the use of digital biomarkers in research, and the integration of digital therapeutics in patient care.

He has served as an editor for iMedicalApps and as a writer for Pharmacy Times, with a focus on mobile apps and digital health. Dr Aungst has also spoken at national and international forums on these topics.

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Objectives



Discuss RPM and how it can help HCPs improve patient care



Highlight technologies that can be used to collect RPM data and how this information can be integrated into traditional health care



Summarize the challenges facing implementation of RPM into health care systems



Explore possible future applications of RPM

HCP, health care provider; RPM, remote patient monitoring.

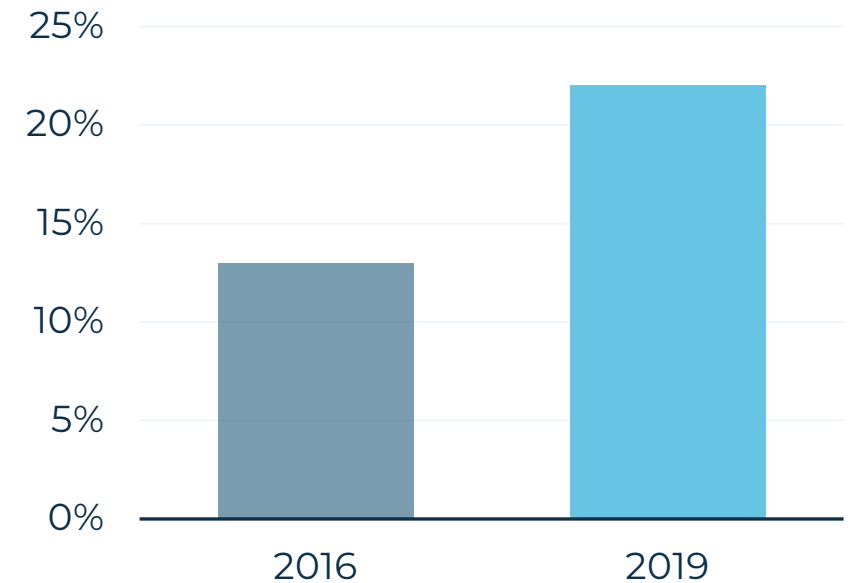
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Introduction To RPM

What Is RPM?

- RPM involves the technology-based collection of data for the purpose of monitoring patients outside the hospital and transmitting the data to HCPs^{1,2}
- RPM tools can highlight potentially significant changes in patient data, which HCPs can use to guide clinical decisions^{3,4}
- The number of surveyed physicians using RPM to improve patient care increased by 9 percentage points between 2016 and 2019⁴

Physicians who used RPM for improving patient care⁴



HCP, health care provider; RPM, remote patient monitoring.

1. Malasinghe LP et al. *J Ambient Intell Human Comput.* 2019;10:57–76.
2. Vegesna A et al. *Telemed J E Health.* 2017;23:3–17.
3. El-Rashidy N et al. *Diagnostics.* 2021;11:607.

4. American Medical Association Digital Health Research. Physicians' motivations and requirements for adopting digital health: Adoption and attitudinal shifts from 2016 to 2019. Published February 2020. Available at: <https://www.ama-assn.org/system/files/2020-02/ama-digital-health-study.pdf>. Accessed March 11, 2022.

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Types Of Data Collected Via RPM

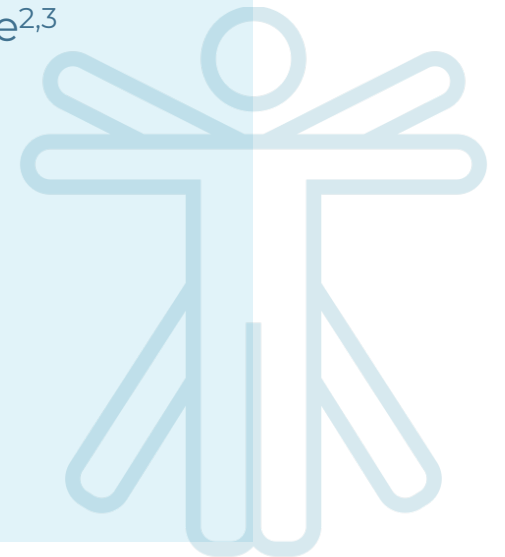


Behavioral data, including:

- Sleep duration and patterns^{1,2}
- Phone usage patterns^{1,2}
- Psychomotor agitation²
- Screen interaction²
- Social activity²
- Mood²
- Conversation frequency²
- Voice features²

Physiological data, including:

- Geolocation²
- Heart rate^{2,3}
- Body or skin temperature^{2,3}
- Blood pressure^{2,3}
- Weight³
- Blood glucose³
- Respiration rate³
- EEG / ECG³
- Pulse oximetry³
- Physical activity³



ECC, electrocardiogram; EEG, electroencephalogram; RPM, remote patient monitoring.

1. Baron KG et al. *Sleep Med Rev*. 2018;40:151-159.

2. Sheikh M et al. *Front Dig Health*. 2021;3:662811.

3. Malasinghe LP et al. *J Ambient Intell Human Comput*. 2019;10:57-76.

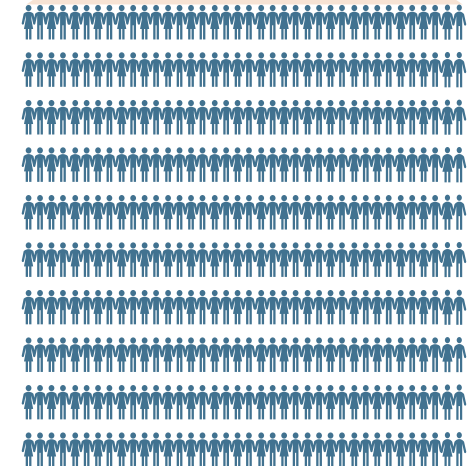
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Why Do We Need RPM?

- Due to the COVID-19 pandemic, in 2020 the global prevalence of MDD increased by 27.6% and for anxiety disorders by 25.6%¹
- There is a **shortage of mental health providers** across the US, with a median of 1 provider per 380 individuals²
 - A survey conducted by the National Council for Behavioral Health found that 38% of patients waited > 1 week for an appointment with a mental health provider³
- Real-time data collected via RPM can help providers **prioritize care** to at-risk patients⁴
 - Alerts prompted by missing or out-of-normal-range data and changes in symptoms related to health deterioration can help indicate which patients need to be seen in-office^{5,6}



1 per 380²



COVID-19, coronavirus disease-2019; MDD, major depressive disorder; RPM, remote patient monitoring; US, United States.

1. Santomauro D et al. *Lancet*. 2021;398:1700–1712.

2. Reinert M et al. The State of Mental Health in America 2022. Published October 2021. Mental Health America, Alexandria VA. Available at: <https://mhanational.org/research-reports/2022-state-mental-health-america-report>. Accessed March 11, 2022.

3. National Council for Behavioral Health. America's Mental Health 2018. Published October 10, 2018. Available at: <https://www.cohenveteransnetwork.org/wp-content/uploads/2018/10/Research-Summary-10-10-2018.pdf>. Accessed March 11, 2022.

4. Aungst T et al. *J Am Coll Clin Pharm*. 2021;4:514–524.

5. Thomas EE et al. *BMJ Open*. 2021;11:e051844.

6. American Medical Association Digital Health Research. Physicians' motivations and requirements for adopting digital health: Adoption and attitudinal shifts from 2016 to 2019. Published February 2020. Available at: <https://www.ama-assn.org/system/files/2020-02/ama-digital-health-study.pdf>. Accessed March 11, 2022.

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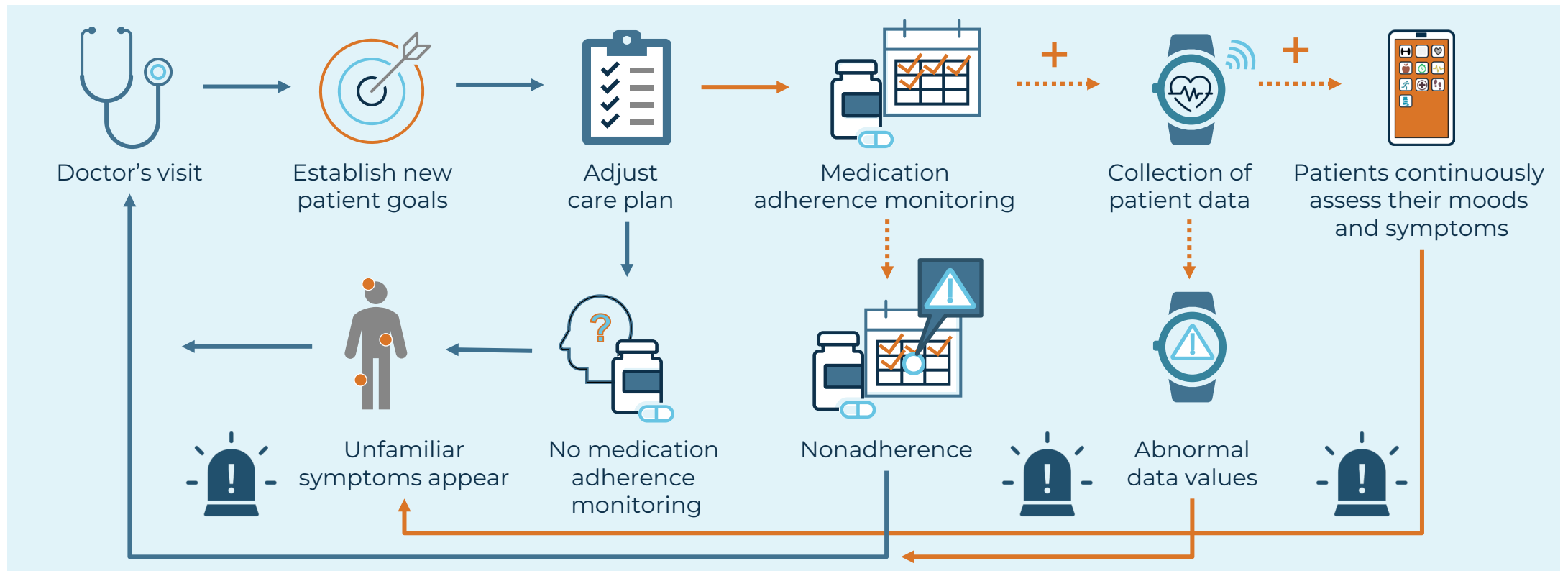
The Current Health Care System Provides Episodic Patient Care¹

Current system: Intermittent patient care

- Every new symptom or medical episode results in a visit to the doctor¹

With integration of RPM data:

- Providers can review patients' health regularly and intervene when necessary²



RPM, remote patient monitoring.

1. Aungst T et al. *J Am Coll Clin Pharm.* 2021;4:514–524.

2. Taylor ML et al. *BMJ Open.* 2021;11:e040232.

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Changes To RPM Regulation And Reimbursement In Response To COVID-19

- In mid-2020, the **FDA issued emergency use authorization for several RPM devices**, including those that monitor¹:
 - QT interval
 - Patient vital signs
 - Cardiac function (eg, ECG devices)
- A 2021 systematic review found that RPM within an acute care setting is applied most often to cardiology and pulmonary therapeutic areas²
 - Other applications of RPM include continuous monitoring of blood glucose in patients with diabetes and those with blood pressure concerns³
- Currently, **7 CPT® codes from the CMS permit reimbursement** of remote monitoring of physiologic data digitally uploaded from an authorized device⁴
- In 2020, **5 CPT® codes were added to the Physician Fee Schedule** to enable billing for remote therapeutic monitoring of nonphysiologic data, including patients' medication adherence, patient-reported medication response, and care management⁴

CMS, Centers for Medicare & Medicaid Services; COVID-19, coronavirus disease-2019; CPT®, Current Procedural Terminology; ECG, electrocardiogram; FDA, Food and Drug Administration; QT, length of time between the beginning of the Q-wave and the end of the T-wave on an ECG; RPM, remote patient monitoring.

1. FDA. Remote or wearable patient monitoring devices: EUAs. Accessed March 11, 2022. Available at: <https://www.fda.gov/medical-devices/coronavirus-disease-2019-covid-19-emergency-use-authorizations-medical-devices/remote-or-wearable-patient-monitoring-devices-euas>.

2. Taylor ML et al. *BMJ Open*. 2021;11:e040232

3. Aungst T et al. *J Am Coll Clin Pharm*. 2021;4:514– 524.










4. Department of Health and Human Services. CMS-1751-F. Published November 19, 2021. Available at: <https://www.govinfo.gov/content/pkg/FR-2021-11-19/pdf/2021-23972.pdf>. Accessed March 11, 2022.

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Integrating RPM Data Into Patient Care

How Might RPM Data Benefit Patient Care?

Inclusion of RPM data in patients' care plans may:

 <p>Provide real-time monitoring of patient data to inform treatment recommendations¹</p>	 <p>Assess patient data collected at home¹ to create continuity between office visits²</p>	 <p>Develop a longitudinal patient health profile to enable care coordination³</p>
 <p>Trigger clinical communication in response to out-of-range data values⁴</p>	 <p>Monitor and improve medication adherence⁵</p>	 <p>Facilitate timely, patient-centered care⁶</p>
 <p>Improve the efficiency of provider workflow via automated data entry into EHRs⁷</p>	 <p>Evaluate sleep quality and duration^{8,9}</p>	 <p>Determine rest-activity cycles, including circadian rhythms²</p>

EHR, electronic health record; RPM, remote patient monitoring.


1. El-Rashidy N et al. *Diagnostics*. 2021;11:607.
2. Hilty DM et al. *J Tech Behav Sci*. 2021;6:252-277.
3. Genes N et al. *npj Dig Med*. 2018;1:23.

4. Taylor ML et al. *BMJ Open*. 2021;11:e040232.
5. Aungst TD. *Expert Rev Med Devices*. 2021;18:25-35.
6. Thomas EE et al. *BMJ Open*. 2021;11:e051844.2021.

7. Kumar RB et al. *J Am Med Inform Assoc*. 2016;23:532-537.
8. Baron KG et al. *Sleep Med Rev*. 2018;40:151-159.
9. Sheikh M et al. *Front Dig Health*. 2021;3:662811.

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Available Technologies To Collect RPM



Smartphones can provide information about users' activity, including screen state, numbers of incoming / outgoing calls, light sensing, and GPS location¹

Apps can provide education, enable communication for providers and patients, and provide health tracking²

- Preinstalled (camera, accelerometer)²
- Downloadable²
- Web-based (require internet connection)²

Longitudinal health monitoring outside the clinical setting can be achieved using wearables,³ including:

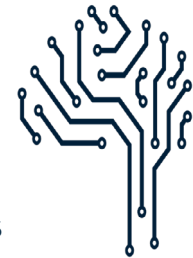
- Smart watches³
- Accelerometers³
- Heart rate monitors³



Smart glasses can expand the breadth of teaching experiences for medical trainees⁴

AI / machine learning can be applied to RPM:

- Ecological momentary assessments of behavior^{1,5}
- Digital exhaust patterns and digital phenotyping⁵
- Algorithm-based risk determination⁶



AI, artificial intelligence; apps, applications; GPS, Global Positioning System; RPM, remote patient monitoring.

1. Dogan E et al. *J Med Internet Res*. 2017;19(7):e262.

2. Aungst TD et al. *Int J Clin Pract*. 2014;68:155–162.

3. Dunn J et al. *Per Med*. 2018;15(5):429–448.

4. Aungst TD. *Int J Clin Pract*. 2015;69:1179–1183.

5. Hirschtritt ME and Insel TR. *Focus (Am Psychiatr Publ)*. 2018;16:251–258.

6. Martinez-Martin N et al. *npj Digit Med*. 2018;1:68.

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Integrating RPM Data Into Clinical Care Decisions

- RPM data can be integrated into EHRs to **deliver large amounts of continuously updated information** to providers, which can collectively be used to develop clinical decision support systems
- Clinical decision support systems can:



Provide a comprehensive view of the patient's medical history



Help non-expert physicians by providing clinical guidelines, practice standards, and differential diagnoses



Remind patients to take their medications, refill prescription medications, take their correct medication dose, and maintain caution around potential interactions with other medications

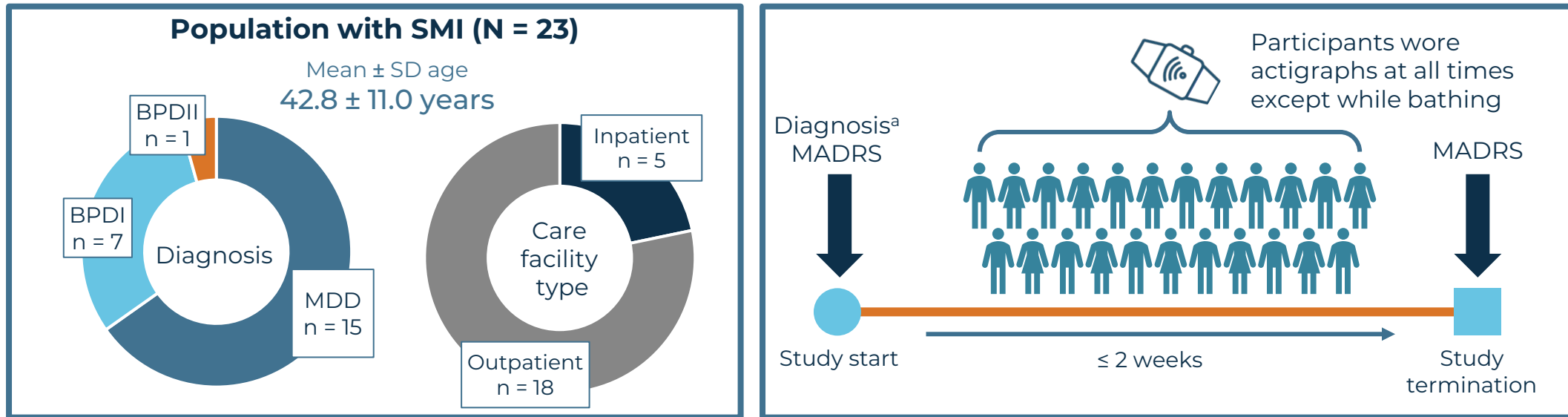
EHR, electronic health record; RPM, remote patient monitoring.

1. El-Rashidy N et al. *Diagnostics*. 2021;11:607.

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Case Study:

Integrating RPM Into The Care Of Patients With SMI



- Digital biomarkers were extracted from passive actigraphy data
- Using solely actigraphy features, the machine-learning algorithm predicted the correct diagnosis (patients versus controls without mental illness^b) 89% of the time
- The change in depression severity predicted by actigraphy features was highly correlated with the actual change from baseline in MADRS scores, with $r = 0.782$ and $P < 0.0001$

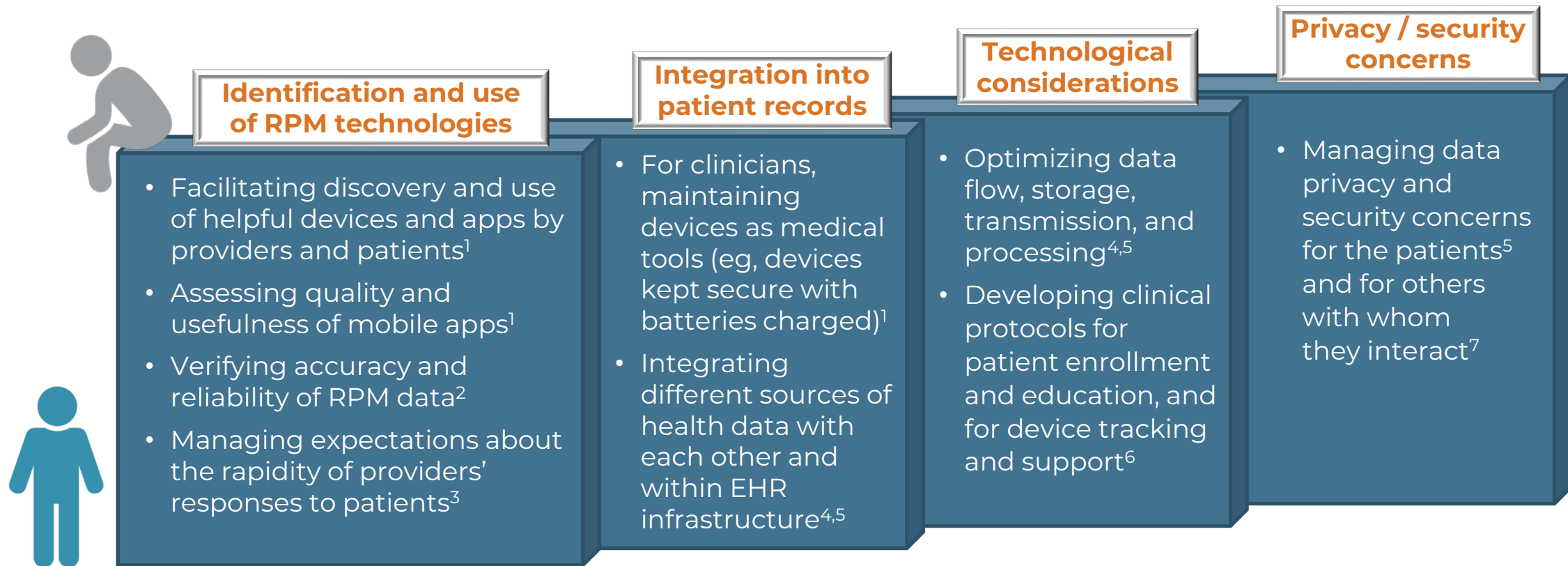
^aPatients with mood disorders were diagnosed by a psychiatrist according to Structured Clinical Interview for DSM-IV criteria. ^bHealthy controls comprised N = 32 individuals without a history of mood or psychotic symptoms.

BPDI, bipolar I disorder; BPDII, bipolar II disorder; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders – 4th edition; MADRS, Montgomery-Åsberg Depression Rating Scale; MDD, major depressive disorder; SD, standard deviation; SMI, serious mental illness.

1. Jacobson NC et al. *NPJ Digit Med.* 2019 Feb 1;2:3.

Challenges With RPM

Challenges Facing The Implementation Of RPM



EHR, electronic health records; RPM, remote patient monitoring.

1. Aungst TD et al. *Int J Clin Pract.* 2014;68:155–162.

2. Malasinghe LP et al. *J Ambient Intell Human Comput.* 2019;10:57–76.

3. Reading MJ and Merrill JA. *J Am Med Inform Assoc.* 2018;25:759–771.

4. Abdolkhani R et al. *Stud Health Technol Inform.* 2018;252:1–7.

5. El-Rashidy N et al. *Diagnostics.* 2021;11:607.

6. Casale PN et al. *Am Coll Med Qual.* 2021;36(3):139–144.

7. Aungst TD. *Int J Clin Pract.* 2015;69:1179–1183.

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Health Inequality In The Use Of Digital Technologies For RPM

Greater demand for mental health care and the COVID-19 pandemic have increased reliance on digital health technologies, which may reinforce preexisting systemic health inequalities in some populations^{1,2}

SDOH factors that can contribute to the risk of health inequalities include:

- Limited health literacy¹
- Low level of education²
- Race²
- Rural location^{2,3}
- Advanced age³
- Low socioeconomic status³
- Limited access to digital devices³

Barriers to implementing digital interventions in **at-risk groups** include:

- Lack of culturally grounded interventions¹
- Low confidence in the quality of digital technologies¹
- Variation in providers' competency with using the technology¹
- Low technology uptake¹
- Underrepresentation of at-risk populations in care settings^{1,3}

COVID-19, coronavirus disease-2019; RPM, remote patient monitoring; SDOH, social determinants of health.

1. Friis-Healy EA et al. *JMIR Ment Health*. 2021;8(1):e25456

2. Wang J et al. *Health Place*. 2021;72:102678.

3. Ogbogu PU et al. *J Allergy Clin Immunol Pract*. 2022 Jan 25:S2213-2198(22)00026-5.

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Strategies To Help Mitigate Health Inequalities

Use **technology** to its strengths (eg, a video depicting correct inhaler usage to overcome low literacy)¹

Expand access and education regarding digital tools usage to historically **vulnerable or underserved** populations²



Employ **real-world data** to expedite the evaluation of outcomes compared with traditional clinical assessment²

Engage **underrepresented users** in the development of RPM tools and apps²

RPM, remote patient monitoring.

1. Ogbogu PU et al. *J Allergy Clin Immunol Pract.* 2022 Jan 25;S2213-2198(22)00026-5.
2. Friis-Healy EA et al. *JMIR Ment Health.* 2021;8(1):e25456
3. Wang J et al. *Heath Place.* 2021;72:102678.

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RPM Into The Future

What Does The Future Hold For RPM?

- A recent scoping review found that wearable devices are being developed for several neuropsychiatric disorders¹
 - Most devices focus on collecting data on motor symptoms and physical activity
 - As of that publication, there were no available devices to directly evaluate psychiatric symptoms
- As patients gain familiarity with RPM, it **may become expected** as part of their care plan²
- Other potential applications of RPM may include:

Hybridized care delivery²



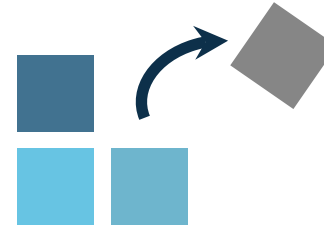
Leverage the strengths of care providers and automated systems²

Digital front door³



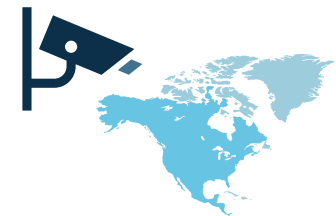
Manage health care demand by directing patients to the best resource for their concerns³

Unbundling reimbursement⁴



Separate CMS reimbursement codes for RPM services in any geographic location (eg, the patient's home)⁴

Public health surveillance⁵



Collect data from heterogeneous populations about daily experiences with illness outside the clinical setting⁵

CMS, Centers for Medicaid & Medicare Services; RPM, remote patient monitoring.

1. Sakamaki T et al. *Telemed J E Health*. 2022 Jan 24.
2. Casale PN et al. *Am Coll Med Qual*. 2021;36(3):139–144.

3. Rastogi N. *BMJ Innovations*. *BMJ Innovations* 2022;8:129–132.
4. Nixon C, Gwilt RE. *Telehealth Med Today*. 2018; 3(1).
5. Al Knawy B et al. *JAMA Network Open*. 2022;5(2):e220214.

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Summary

1

RPM involves the use of technology to collect data from patients outside a clinical setting and remote transmission to providers^{1,2}

2

RPM data can clarify medical decision-making and help identify at-risk patients who need additional intervention^{3,4}

3

Several challenges face implementation of RPM, particularly for patient privacy and digital safety^{5,6}

4

In the future, RPM holds promise to help facilitate continuous care of patients with chronic conditions⁷

RPM, remote patient monitoring.

1. Malasinghe LP et al. *J Ambient Intell Human Comput.* 2019;10:57–76.
2. Vegesna A et al. *Telemed J E Health.* 2017;23:3–17.
3. Martinez-Martin N et al. *npj Digit Med.* 2018;1:68.
4. Taylor ML et al. *BMJ Open.* 2021;11:e040232.

5. Aungst TD. *Int J Clin Pract.* 2015;69:1179–1183.
6. El-Rashidy N et al. *Diagnostics.* 2021;11:607.
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