

Supplementary Appendices

Supplementary Appendix S1 Table of Carealign data sources

Data type	Data source	Request type	Response time
Care team and contacts			
Inpatient treatment team	Epic (via homegrown portal)	Scheduled API request	Near real-time
Primary care provider	Epic Clarity Database	Direct query	Within 24 hours
Provider contact information	Epic	Scheduled API request	Near real-time
Health system phonebook	Direct query	Real-time	
Vitals			
Vital signs from flowsheets	Epic	HL7 transactions	Real-time
Intake and output	Epic	On-demand API	Real-time
Labs and pathology			
General laboratory results, microbiology results, anatomic pathology reports	Cerner	HL7 transactions	Real-time
Studies			
Cardiology			
ECGs	Muse	HL7 transactions	Real-time
All other results (i.e., echocardiograms, vascular studies, catheterization reports, EP procedure reports)	Epic (2018–present)	HL7 transactions	Real-time
	ProSolv (2009–2018) Siemens Syngo (2013–2018) Encapture MD (2011–2018)	<i>No longer in use but reports are available in Carealign</i>	
Dermatopathology			
Biopsy results	New Path (Department of Dermatology)	Direct query	Real-time
Gastroenterology			
Endoscopy reports	ProVation (2017–present)	HL7 transactions	Real-time
	Olympus Endoworks (2006–2017)	<i>No longer in use but reports are available in Carealign</i>	
Neurology			
EEGs, neurovascular studies	Department of Neurology (via homegrown portal)	Direct query	Real-time
EMGs	Epic, Epic Clarity	Direct query	Within 24 hours
Obstetrics and gynecology			
Ultrasounds	A/S	HL7 transactions	Real-time
Pulmonology			
Pulmonary function tests	MedGraphics Breeze	HL7 transactions	Real-time
Radiology			
Imaging reports	Epic Radiant	On-demand API	Real-time
Diet			
Diet orders	Epic	HL7 transactions	Real-time
Allergies			
Allergies	Epic	HL7 transactions	Real-time

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Supplementary Appendix S1 (Continued)

Data type	Data source	Request type	Response time
Medications			
Inpatient medications and MAR	Epic	HL7 transactions	Real-time
Home medications	Epic	On-demand API	Real-time
Encounters and documentation			
Encounters	Epic	HL7 transactions	Real-time
Notes and documents			
Progress notes	Epic	On-demand API	Real-time
ED notes	Epic ASAP	On-demand API	Real-time
Telephone encounters	Epic Clarity	Direct query	Within 24 hours
Other Data			
Patient demographics, assigned and current location	Epic	HL7 transactions	Real-time
Code status	Epic	Scheduled API request	Near real-time
Infection flag	Epic	Scheduled API request	Near real-time
Patient room phone number	Application stored database	Direct query	Static

Abbreviations: API, application-program interface; ECG, electrocardiogram; ED, emergency department; EEG, electroencephalogram; EMG, electromyogram; EP, electrophysiology; HL7, Health-Level 7; MAR, medication administration record; PCP, primary care provider.
 Note: When the Carelign initiative began and through implementation in 2016, our health system was using EpicCare (Epic Systems Corporation, Verona, Wisconsin, United States) for ambulatory care, Sunrise (Allscripts Healthcare Solutions Inc., Chicago, Illinois, United States) for inpatient care, Cerner (Cerner Corporation, Kansas City, Missouri, United States) for the laboratory information, and over 10 additional specialized systems to support Penn Medicine’s clinical data needs. One year after Carelign’s implementation, Penn Medicine transitioned its inpatient and emergency care EHR solutions to the EpicCare platform (October 2016–March 2017). Carelign’s data sources were transitioned accordingly.

Supplementary Appendix S2 2016 and 2018 User Survey questions

September 2016 User Survey	
1.	What is your patient care role?
	RN—Clinical RN—Nurse manager/charge RN—Student APP MD—Attending MD—Fellow MD—PGY1 resident MD—PGY2 resident MD—PGY3 resident MD—PGY4 resident MD—PGY5+ resident MS—Clerkship MS—Elective/sub-intern Physical therapist Occupational therapist Pharmacist SW/CRC Clinical nutritionist Respiratory therapist Speech and swallow Dietary associate Other
2.	Select your training program:
	Medicine Surgery OB/GYN Neurology Psychiatry Radiology Family medicine Home care Multiple specialties Other
3.	Please select your main area of practice:
	Medicine Surgery OB/GYN Neurology Psychiatry Radiology Family medicine Home care Multiple specialties Other
4.	Do you use Carelign?
	Yes No
5.	How long have you been using Carelign?
	12 or more months 7–12 months 0–6 months
6.	In what settings have you used Carelign? (Select all that apply)
	Medical floor Medical ICU Surgical floor

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Supplementary Appendix S2 (Continued)

	Surgical ICU ED, short stay units Procedural areas Ambulatory Home care L&D Diagnostics Other
7.	Do you use Carelign for handoff/signouts?
	Yes No Unsure
8.	How long have you been using Carelign for handoffs/signouts?
	12 or more months 7–12 months 0–6 months
9.	When do you use Carelign? (Select all that apply)
	During transitions in care (handoff, signout, shift report, etc.) While prerounding During rounds While writing notes While talking to patients While on call While off campus Other
10.	Do you use Carelign at the patient bedside? (Select all that apply)
	Yes, to review data in response to patient questions Yes, to review data not prompted by patient questions Yes, to view the handoff/signout Yes, to update the handoff/signout No
11.	When using Carelign at the patient bedside, do you show/share what you are looking at with the patient (either verbally or visually)?
	Always Often Sometimes Seldom Never
12.	Do you feel comfortable using Carelign?
	Yes No
13.	On a scale of 1 to 5, how comfortable do you feel using Carelign?
	1—Not very comfortable; I struggle to use it 2 3—Generally comfortable; I can get my work done 4 5—Very comfortable; I am proficient and can teach others
14.	How long did it take you to initially learn to use Carelign well enough to get your work done?

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Supplementary Appendix S2 (Continued)

	<1 day 2-3 days 1 week >1 weeks
15.	How long did it take you to reach your current level of comfort using Carelign?
	<2 weeks 2-4 weeks 1-3 months >3 months
16.	Rate your level of agreement with the following statements: 1 (Strongly disagree); 2-3 (neither agree nor disagree); 4-5 (strongly agree) "Carelign...
	...enables me to make more timely clinical decisions ...improves communication between health care providers ...improves communication between providers and patients ...enables safer transitions in care ...improves the quality of my documentation ...improves my understanding of the patient plan ...has improved the quality of my work life"
17.	Does Carelign enable you to do things/tasks that you were unable to do previously?
	No Unsure Yes, please describe (free text option)

Supplementary Appendix S2 (Continued)

18.	On a scale from 0-10, how likely are you to recommend Carelign to a friend or colleague?
19.	What do you like the most about Carelign? (Free text)
20.	What is one thing you would change about Carelign? (Free text)
21.	In what way could Carelign be improved to better fit your clinical workflows? (Free text)
22.	Additional questions, comments, or concerns for the Carelign team? (Free text)
<i>April 2018 User Survey</i>	
1.	Would it take more time for you to do your job without Carelign?
	Yes No Unsure
2.	Do you feel using Carelign has helped you prevent a medical error?
	Yes No Unsure
3.	If you left Penn Medicine, would you want to take Carelign with you?
	Yes No Unsure

Abbreviations: ICU, intensive care unit; ED, emergency department; GYN, gynecology; OB, obstetrics.