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Use of Electronic Health Records to Support Pilot Aeromedical Certification

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12. Abstract The FAA Office of Aerospace Medicine (AVS-AAM) plays a key role in aviation safety by establishing medical standards for flight fitness and by issuing pilot medical certifications. To gather the information needed to perform this role, the FAA uses a network of Aviation Medical Examiners who administer pilot examinations at specified intervals. MITRE CAASD explored the feasibility of electronic medical record data integration into the aeromedical certification process to expedite the collection of already available information. The research involved literature review and policy analysis, workflow analysis of the existing MedXPress website, database analysis, terminology mapping, stakeholder process mapping, and preliminary integration testing with major Electronic Health Record (EHRs) vendors. The study recommended addressing different workflows for different stakeholders and ensuring that the Privacy Policy is up to date and accurately reflects current implementations. The report underscored the need for legal consultation during the implementation process, as different data ownership regulations apply depending on who accesses and owns the data. It also recommended the use of health aggregation services, such as health information exchanges and Patient Health Record patient-data aggregators, to gather the necessary longitudinal data from EHRs needed for the pilot examination.	
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List of Abbreviations

AAM	Office of Aerospace Medicine
ANSI	American National Standards Institute
AME	Aviation Medical Examiners
APA	Allied Pilots Association
API	Application Programming Interface
ARC	Pilot Fitness Aviation Rulemaking Committee
ASIAS	Aviation Safety Information Analysis and Sharing
ATC	Air Traffic Control
BAA	Business Associate Agreement
CAASD	Center for Advanced Aviation System Development
CACI	Conditions AMEs Can Issue (CACI)
CFR	Code of Federal Regulation
DICOM	Digital Imaging and Communications in Medicine
DOD	Department of Defense
DOT	Department of Transportation
DSM-V	Diagnostic and Statistical Manual of Mental Disorders
ECG	Electrocardiogram
EHR	Electronic Health Record
EMR	Electronic Medical Record
EOB	Explanation of Benefits
FAA	Federal Aviation Administration
FHIR	Fast Healthcare Interoperability Resources
HIPAA	Health Insurance Portability and Accountability Act
HL7	Health Level Seven, International
HIE	Health Information Exchange
ICD	International Classificatin of Diseases
JSON	JavaScript Object Notation
LOINC	Logical Observation Identifiers, Names, and Codes

OIG	Office of the Inspector General
ONC	Office of the National Coordinator
PDF	Portable Document Format
QHIN	Qualified Health Information Network
SME	Subject Matter Expert
SNOMED	Systematized Nomenclature of Medicine – Clinical Terms
SODA	Statement of Demonstrated Ability
USCORE	Core requirements for US Realm FHIR implementation as described in https://www.hl7.org/fhir/us/core/
XML	eXtended Markup Language

Abstract

The FAA Office of Aerospace Medicine (AVS-AAM) plays a key role in aviation safety by establishing medical standards for flight fitness and by issuing pilot medical certifications. To gather the information needed to perform this role, the FAA uses a network of Aviation Medical Examiners who administer pilot examinations at specified intervals. MITRE CAASD explored the feasibility of electronic medical record data integration into the aeromedical certification process to expedite the collection of already available information. The research involved literature review and policy analysis, workflow analysis of the existing MedXPress website, database analysis, terminology mapping, stakeholder process mapping, and preliminary integration testing with major Electronic Health Record (EHRs) vendors. The study recommended addressing different workflows for different stakeholders and ensuring that the Privacy Policy is up to date and accurately reflects current implementations. The report underscored the need for legal consultation during the implementation process, as different data ownership regulations apply depending on who accesses and owns the data. It also recommended the use of health aggregation services, such as health information exchanges and Patient Health Record patient-data aggregators, to gather the necessary longitudinal data from EHRs needed for the pilot examination.

Introduction

The Federal Aviation Administration (FAA) Aviation Safety Office of Aerospace Medicine (AVS/AAM) tasked The MITRE Corporation Center for Advanced Aviation System Development (CAASD) to determine the feasibility of using Electronic Health Records (EHR) to assist in the completion and/or validation of Form 8500-8, *Application for Airman Medical Certificate or Airman Medical & Student Pilot Certificate* (Federal Aviation Administration, n.d.). Form 8500-8 is the data collection document used by the FAA to collect medical history for candidates to determine fitness to fly aircraft or perform air traffic control duties. EHRs are the primary data management, storage, and coordination systems used by healthcare centers across the US, including acute care hospitals, outpatient clinics, and specialty practices (The Office of the National Coordinator for Health Information Technology (ONC), n.d.).

New federal regulations such as the Medicare Access and CHIP Reauthorization Act of 2015 (114th Congress of the United States of America, 2015); the 21st Century Cures Act (114th Congress of the United States of America, 2016); the Coronavirus Aid, Relief, and Economic Security Act (CARES) (116th Congress of the United States of America, 2020); and Trusted Exchange Framework and Common Agreement (TEFCA) (The Office of the National Coordinator for Health Information Technology (ONC), n.d.) have outlined requirements to be met for utilizing medical record data in ancillary industries, creating the opportunity for the FAA to join health data with operational data[1] to enable data driven certification decision making.

This report demonstrates the technical feasibility of using EHR data to populate Form 8500-8. It summarizes research opportunities for FAA to use this data for safety assurance and airman medical certification processes, including special issuances.

By successfully demonstrating technical feasibility in this research, the FAA is now positioned to invest in a future state concept of operations for aeromedical certification, recertification, and

[1] The FAA does not currently have access to operational flight data. Fusion of operational and health data would likely depend on a data-sharing, multi-party collaborative to identify insights not otherwise possible (Sienknecht, 2021).

special issuance that includes EHR data. If future phases of this research are successful, AAM will accelerate data acquisition, limit/eliminate non-disclosure, and will be able to continuously and proactively monitor for aeromedical-relevant health risks, thereby positioning itself to realize tangible process efficiencies and achieve its overall goals of accelerating aeromedical decisions, safety and quickly recertifying applicants, and reducing unnecessary actions to revoke or suspend a medical certificate without compromising on safety.

Current Landscape

The FAA plays a key role in aviation safety by establishing airman medical standards, medical fitness for duty, and issuing medical certificates. To gather the information needed to perform this role, the FAA uses a network of Aviation Medical Examiners (AMEs), who administer airman examinations at specified intervals (a process which includes collection of data prescribed on FAA Form 8500-8[2] and subsequent follow-up activities). In 2007, the FAA introduced MedXPress (Federal Aviation Administration, n.d.) to digitize and facilitate the online submission of Form 8500-8. Data entered in MedXPress by the applicant is made available to their AME for the exam required to complete certification (Federal Aviation Administration, 2023).

Since much of the data furnished by the airman and AME may already reside in the airman's medical records, this research sought to determine whether EHRs could be successfully used to complete and validate related items on Form 8500-8. Usage of healthcare organizations' EHR data in third party systems is a relatively new practice, with application programming interface (API) standards still evolving (The Office of the National Coordinator for Health Information Technology (ONC), n.d.), along with emerging codes of conducts (CARIN Alliance, n.d.), and trust frameworks (The Office of the National Coordinator for Health Information Technology (ONC), n.d.). EHR data is typically siloed within individual healthcare institutions, so a patient's data does not reside in one place. However, the EHR ecosystem consists of ancillary systems and services, such as personal health records (PHRs) and health information exchanges (HIEs). PHRs and HIEs aggregate health data and offer a more complete medical history than healthcare data stored at an individual healthcare facility. Personal health records are of particular interest, as they contain much of the same functionality as a hospital EHR, except they are single-user and miniaturized to run on devices such as a smartphone and allow a convenient place to synchronize and store data from consumer medical devices. Meanwhile, HIEs and other health data aggregators are creating trust networks, which act as distribution channels of health data to authorized users.

While disruptive in some regards to legacy business models, these technologies offer the possibility of reducing the overall administrative burden for applicants, medical examiners, and the FAA if applicants can use them to share data required for medical certification and special issuances. As the FAA is largely reliant on complete, truthful recollection of medical history by applicants, these technologies may also address the issue of pilot non-disclosure.

For decades, medical record data has been regulated by the Privacy Act of 1974 (United States Department of Justice) and the Health Insurance Portability and Accountability Act of 1996 (HIPAA), both of which specify penalties for inappropriate data sharing. The legal and financial risks associated with violating these regulations had the unintended consequence of creating a culture around protected health information (PHI) and privacy that encouraged healthcare data systems to become siloed, resulting in them being largely inaccessible by and unusable with other

[2] See Appendix H: Form 8500-8 for more information.

data systems.

However, with the 21st Century Cures Act (114th Congress of the United States of America, 2016), which specified penalties for information blocking (siloing) and rights to patient data ownership, the patient now has pathways for becoming the custodian of their own health data and has the rights to use that data as they see fit. This presents an opportunity for the FAA to re-evaluate and/or redesign risk controls associated with medical fitness hazards (including but not limited to aeromedical certification), and to benefit from opportunities arising from availability of standardized health data. By having the airmen obtain copies of their own medical records in digital format from each hospital or clinic they've visited, and act as custodian and intermediary using a PHR, the FAA has an alternate pathway to obtain the patient's EHR data than by directly contacting the hospitals themselves.

Methodology and Approach

MITRE performed a systems analysis of the Form 8500 component of the MedXPress website and a decomposition of the data requirements for Form 8500-8. This included a review of data tables related to Form 8500 function exported from MedXPress, and identification of use cases to illustrate a variety of stakeholder needs. A literature review was conducted of applicable legal frameworks and federal policies, including relevant federal API standards for health data. In conjunction with this research, we also conducted a market survey and review of relevant services available in EHR stores and App stores to inform potential implementation. Finally, a Substitutable Medical Applications and Reusable Technologies (SMART) (Computational Health Informatics Program, Boston Children's Hospital, n.d.) on Fast Healthcare Interoperability Resource (FHIR) (Health Level Seven International, n.d.) data prototype was developed to demonstrate the technical feasibility of using EHR data to complete or validate the Form 8500-8.

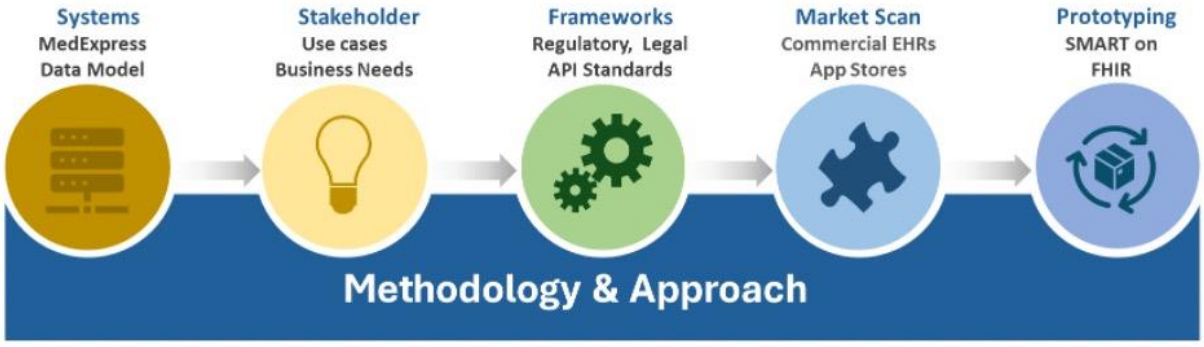

Figure 1. Methodology and Approach.

Analysis and Results

Technical Feasibility

The completion of Form 8500-8 is comparable to a preventative screening questionnaire in a clinical healthcare setting. In broad terms, it comprises patient medical and surgical histories, medications, a review of physiology and organ systems, and a physical examination which may include ancillary tests such as urinalysis and electrocardiograms (ECGs). Using EHR data in the context of FAA medical certification effectively involves creating a preventive medical exam report;

one that leverages information available in the pilot's EHR records to populate the elements of Form 8500-8.

EHR systems log medical and health data from multiple modalities, looking at the human body from different levels of organization (e.g., genetic, cellular, organ system, behavior). This construct is typically translated to different data types, such as genomics data, laboratory results, medical imaging, and clinical notes. Each of the physical exam elements requested on Form 8500-8 may be recorded in multiple formats, depending on whether a medical examiner requested an eye exam, medical imaging of the orbital socket, a lab value related to an ocular condition, or other clinical evidence. FHIR APIs can provide textual information such as laboratory results and clinical notes but need special considerations to furnish large data files such as radiology images or genomics, which should not be considered generally available.

Although all medically relevant fields in Form 8500-8 can be expressed and transmitted via FHIR APIs, this does not guarantee data will be available for individual applicants or available data will be technically feasible for use by FAA or AMEs. The following criteria were used to establish the technical feasibility of extracting information from EHRs for the FAA's medical certification needs:

- Vendor support of data schemas relevant to the form item
- Support of form item in major terminologies[3] (e.g., SNOMED, LOINC, RxNorm, DSM-V)
- Whether support for the form item is mandated by federal law via the Office of the National Coordinator (ONC) U.S. Core Elements for Interoperability (e.g., sex at birth, vital signs, advanced directives)
- Geographical data availability[4] (i.e., support for the data is specific to some jurisdictions, such as with cannabis)
- Granularity of available data versus what the form item requests (e.g., dosage vs. medication type; radiology procedure vs. specific studies collected)

On a terminology basis, all medical conditions mentioned in Form 8500-8 and special issuance guidance as of May 2024 have associated SNOMED codes. All exams mentioned in Form 8500-8 and special issuance guidance have associated LOINC codes. Finally, all prescribed pharmacy medications can be queried from EHR data using RxNorm codes, except for the following:

1. Over the counter medications, such as Benadryl
2. Over the counter nutraceuticals and herbal remedies, such as valerian root tea
3. Schedule 1 restricted drugs that have not been assigned an RxNorm value, such as medical cannabis

The regulation of some medications and medical procedures, such as abortion, birthing doulas, cannabis, and psilocybin, varies by state. Some health systems may track differences in data by geographic location but are likely to use state level medication codes, which FHIR supports, and not RxNorm codes.

Not all healthcare systems run their own laboratories, pharmacies, or imaging centers. As such, a single applicants' data may be split across several different EHR systems. Obtaining complete Form 8500-8 may involve querying/contacting the hospital for inpatient visits, medical encounters, exams, and problem lists; and contacting separate laboratory services for lab results. Of note, the

[3] See Appendix G: Terminology Codes
[4] Estimated using publicly available market surveys.

same APIs are used to query medication in both systems (i.e., the health care provider and the laboratory services).

Purchase or use of over-the-counter medications is not currently tracked in EHR data, unless prescribed by a clinician or healthcare provider in clinical notes. Even when listed in clinical notes, they cannot be queried using RxNorm codes and additional text analysis is necessary to extract over-the-counter medications from free-form text.

The feasibility and challenges of using EHR data to populate Form 8500-8 are summarized in Table 1 and Table 2. Feasibility and availability of each relevant Form 8500-8 element is expressed as (Y) feasible, (E) possible using an extension, (P) partial data is available, (U) feasible, but unlikely to be present, or (N) not feasible. Items 60-64 were not assessed for EHR feasibility because the AME will still be responsible for populating those fields (Federal Aviation Administration, 2014).

Table 1. Applicant History (1-20) Form 8500-8 Feasibility.

EXAM ELEMENT	8500-8 ITEM	FEASIBLE	SCHEMA DETAILS	NOTES
APPLICATION FOR	1	N	N/A	Not applicable.
CLASS OF MEDICAL CERTIFICATE APPLIED FOR	2	N	N/A	Not applicable.
LAST NAME; FIRST NAME; MIDDLE NAME	3	Y	FHIR Patient.name	
SOCIAL SECURITY NUMBER (SSN)	4	Y	FHIR Patient.identifier	
ADDRESS AND TELEPHONE NUMBER	5	Y	FHIR Patient.address	
DATE OF BIRTH	6	Y	FHIR Patient.birthDate	
SEX	9	Y/E	FHIR Patient.gender FHIR USCORE sexAssignedAtBirth	See discussion below
TYPE OF AIRMAN CERTIFICATE(S) YOU HOLD	10	U	FHIR Patient.identifier FHIR DocumentReference	Unlikely to be present in general hospital EHRs, but could be collected at airport medical clinics as part of patient intake
COLOR OF HAIR	7	U	FHIR Observation Personal Characteristics IG	Unlikely to be present, but the API fully supports recording this data.
COLOR OF EYES	8	U	FHIR Observation Personal Characteristics IG	Unlikely to be present, but the API fully supports recording this data.
OCCUPATION	11	Y	FHIR Observation	Occupational Data for Health Code System
EMPLOYER	12	Y	FHIR Observation	Occupational Data for Health Code System
HAS YOUR FAA AIRMAN MEDICAL CERTIFICATE EVER BEEN DENIED, SUSPENDED, OR REVOKED?	13	U	FHIR Practitioner.qualification	See [5]
DATE OF LAST FAA MEDICAL APPLICATION	16	U	FHIR Practitioner.qualification	See [5]
TOTAL PILOT TIME TO DATE	14	U/E	FHIR Encounter	May require extension; and possibly a PHR to track patient-contributed data

[5] Unlikely that hospitals would have this data; but not substantially different from a driver's license or medical license; If the pilot presented the certificate, it could be tracked by an EHR the same as a driver's license, insurance card, or medical license.

EXAM ELEMENT	8500-8 ITEM	FEASIBLE	SCHEMA DETAILS	NOTES
TOTAL PILOT TIME PAST 6 MONTHS	15	U/E	FHIR Encounter	May require extension; and possibly a PHR to track patient-contributed data
DO YOU CURRENTLY USE ANY MEDICATION (PRESCRIPTION OR NONPRESCRIPTION)?	17a	Y	FHIR Medication FHIR MedicationRequest FHIR MedicationAdministration	As described earlier, this is unlikely to include over-the-counter medications, non-prescription medications, nutraceuticals, and Schedule 1 medications which have not been assigned an RxNorm code, such as medical cannabis
DO YOU EVER USE NEAR VISION CONTACT LENS(ES) WHILE FLYING?	17b	N		Must ask pilot regarding their behavior in-flight
MEDICAL HISTORY	18a-u, x, y		See [6] for 18a-u, x, y	Querying medical history and insurance claims data through FHIR requires a variety of data schemas, which are documented in detail in the following implementation guides: - Argonaut Data Query - International Patient Summary - Standard Personal Health Record - Vaccine Credential Initiative - EHI Export - Bluebutton - DaVinci Some medical claims data may be available from commercial data vendors or an applicant's insurance providers. 18a through 18q can all be exchanged via FHIR.
FREQUENT OR SEVERE HEADACHES	18a	Y		See [7] for more details.
DIZZINESS OR FAINTING SPELLS	18b	Y		See [7] for more details.
UNCONSCIOUSNESS FOR ANY REASON	18c	Y		See [7] for more details.
EYE OR VISION TROUBLE EXCEPT GLASSES	18d	Y		See [7] for more details.
HAY FEVER OR ALLERGY	18e	Y		See [7] for more details.
ASTHMA OR LUNG DISEASE	18f	Y		See [7] for more details.
HEART OR VASCULAR TROUBLE	18g	Y		See [7] for more details.
HIGH OR LOW BLOOD PRESSURE	18h	Y		See [7] for more details.
STOMACH, LIVER, OR INTESTINAL TROUBLE	18i	Y		See [7] for more details.
KIDNEY STONE OR BLOOD IN URINE	18j	Y		See [7] for more details.
DIABETES	18k	Y		See [7] for more details.
NEUROLOGICAL DISORDERS; EPILEPSY, SEIZURES, STROKE, PARALYSIS, ETC.	18l	Y		See [7] for more details.

[6] See the following FHIR schemas: AllergyIntolerance, Claim, Condition, Consent, Coverage, DiagnosticReport, DocumentReference, Encounter, ExplanationOfBenefit, Immunization, Observation, Procedure

[7] Yes, depending on services offered at clinic. All these items are generally covered by SNOMED or LOINC codes and can be queried via FHIR according to federal standards (USCORE).

EXAM ELEMENT	8500-8 ITEM	FEASIBLE	SCHEMA DETAILS	NOTES
MENTAL DISORDERS OF ANY SORT; DEPRESSION, ANXIETY, ETC.	18m	Y/U		See [8] for more details.
SUBSTANCE DEPENDENCE; OR FAILED A DRUG TEST EVER; OR SUBSTANCE ABUSE OR USE OF ILLEGAL SUBSTANCE IN THE LAST 2 YEARS	18n	Y/U		See [8] for more details.
ALCOHOL DEPENDENCE OR ABUSE	18o	Y/U		See [8] for more details.
SUICIDE ATTEMPT	18p	Y/U		See [8] for more details.
MOTION SICKNESS REQUIRING MEDICATION	18q	Y		
MILITARY MEDICAL DISCHARGE	18r	Y/U		Would likely need to query hospitals administrated by US Department of Veteran Affairs hospitals (which support FHIR); Other hospitals are unlikely to have discharge data.
MEDICAL REJECTION BY MILITARY SERVICE	18s	U		Unlikely to be present in Veterans Affairs systems, since the individual would not be a veteran
REJECTION FOR LIFE OR HEALTH INSURANCE	18t	P	DaVinci CDeX FHIR Coverage	Insurers are implementing FHIR interfaces for claims data and clinical data exchange; so entirely possible to get coverage lapses and possibly denials.
ADMISSION TO HOSPITAL	18u	Y	FHIR Encounter	
OTHER ILLNESS, DISABILITY, OR SURGERY	18x	Y		EHRs will provide copious amounts of data regarding other illnesses and disabilities, above and beyond minimal Form 8500 requirements
MEDICAL DISABILITY BENEFITS	18y	Y/U	ExplanationOfBenefit	The FHIR protocol supports the exchange of Explanation of Benefit (EOB) information, but current federal requirements[9] don't require it EHR vendors or healthcare providers to implement support
EXPLANATIONS BOX				
ARRESTS, CONVICTIONS, ADMINISTRATIVE ACTIONS V. HISTORY OF ARREST(S), CONVICTION(S) AND/OR ADMINISTRATIVE ACTION(S) W. HISTORY OF NONTRAFFIC CONVICTIONS	18 v, w	U	FHIR Composition FHIR DocumentReference	Unlikely to have this data, but basic demographic and arrest information can be modeled with FHIR; Hospitals which provide care to correctional facilities may have this documentation in their systems, but likely in PDF format
VISITS TO HEALTH PROFESSIONAL WITHIN LAST 3 YEARS	19	Y	FHIR Encounter	
APPLICANT'S NATIONAL DRIVER REGISTER AND CERTIFYING DECLARATION	20	Y	FHIR Composition FHIR DocumentReference	Unlikely to have, but hospital may have copy of driver's license during intake procedure

Table 2. Exam Techniques (21-58) - Form 8500-8 Feasibility

EXAM ELEMENT	8500-8 ITEM	FEASIBLE	SCHEMA DETAILS	NOTES
HEIGHT	21	Y	FHIR Observation	See the following implementation guides:

[8] Could be available in Observation, Condition, or Medication records. May be filtered based on privacy laws at a state-by-state basis.
[9] As of May 2024.

EXAM ELEMENT	8500-8 ITEM	FEASIBLE	SCHEMA DETAILS	NOTES
				- Personal Characteristics **- Vital Signs**
WEIGHT	22	Y	FHIR Observation	See the following implementation guides: **- Personal Characteristics** **- Vital Signs**
STATEMENT OF DEMONSTRATED ABILITY (SODA) ISSUED?	23	Y	See [10] for more details.	Unlikely to be recorded as "SODA", but reasonable that a physician could write an equivalent document and store in the EHR
SODA SERIAL NUMBER	24	Y	See [10] for more details.	
HEAD, FACE, NECK AND SCALP	25	Y	See [11] for more details.	
LUNGS AND CHEST	35	Y	See [11] for more details.	
HEART	36	Y	See [11] for more details.	
VASCULAR SYSTEM	37	Y	See [11] for more details.	
ABDOMEN AND VISCERA	38	Y	See [11] for more details.	
ANUS	39	Y	See [11] for more details.	
SKIN	40	Y	See [11] for more details.	
GENITOURINARY SYSTEM	41	Y	See [11] for more details.	
MUSCULOSKELETAL UPPER AND LOWER EXTREMITIES	42	Y	See [11] for more details.	
SPINE, OTHER MUSCULOSKELETAL	43	Y	See [11] for more details.	
IDENTIFYING BODY MARKS, SCARS, TATTOOS	44	Y	See [11] for more details.	
LYMPHATICS	45	Y	See [11] for more details.	
NEUROLOGICAL	46	Y	See [11] for more details.	
GENERAL SYSTEMIC	48	Y	See [11] for more details.	
PSYCHIATRIC	47	P	• FHIR Composition • FHIR DiagnosticReport	Some of this data may be inferred from Condition codes or Medication data; but generally speaking, FAA should not expect psychiatric or therapist notes via FHIR
HEARING	49	Y	See [12] for more details.	See [13] for more details.
NOSE	26	Y	See [12] for more details.	See [13] for more details.
SINUSES	27	Y	See [12] for more details.	See [13] for more details.
MOUTH AND THROAT	28	Y	See [12] for more details.	See [13] for more details.

[10] See FHIR Composition and DocumentReference schemas.

[11] See FHIR BodyStructure, Condition, DiagnosticReport, DocumentReference, Observation, Procedure, and DICOM WEB. Many of the Form 8500-8 exam elements refer to organ systems, which may be modeled and recorded in an EHR in numerous ways. The most generic approach will be via clinical notes, generally available via DiagnosticReport or DocumentReference resources. Items on a patient's problem list will generally be recorded with SNOMED codes, and available as conditions, procedures, or observation resources; These would be inclusive of vital signs and laboratory data. The most specific and granular approach will be via DICOM data, tagged with BodyStructure elements; Few systems will have this data available via API, but the approach is feasible.

[12] See FHIR Observation, Procedure, and Condition schemas.

[13] Audiology and Ear/Nose/Throat (ENT) is somewhat less developed than other areas; but there are notable efforts in modeling these specialties; particularly in Australia; See the **PACIO Speech Language** and **AU Diagnostic Hearing** implementation guides for more details.

EXAM ELEMENT	8500-8 ITEM	FEASIBLE	SCHEMA DETAILS	NOTES
EARS, GENERAL	29	Y	See [12] for more details.	See [13] for more details.
EAR DRUMS	30	Y	See [12] for more details.	See [13] for more details.
EYES, GENERAL	31	Y	See [12] for more details.	See [14] for more details.
OPHTHALMOSCOPIC	32	Y	See [12] for more details.	See [14] for more details.
PUPILS (EQUITY AND REACTION)	33	Y	See [12] for more details.	See [14] for more details.
OCCULAR MOTILITY	34	Y	See [12] for more details.	See [14] for more details.
DISTANT VISION	50	Y	See [12] for more details.	See [14] for more details.
NEAR VISION	51.A	Y	See [12] for more details.	See [14] for more details.
INTERMEDIATE VISION	51.B	Y	See [12] for more details.	See [14] for more details.
COLOR VISION	52	Y	See [12] for more details.	See [14] for more details.
FIELD OF VISION	53	Y	See [12] for more details.	See [14] for more details.
HETEROPHORIA	54	Y	See [12] for more details.	See [14] for more details.
BLOOD PRESSURE	55	Y	• FHIR Observation • FHIR Condition	See the following implementation guides: **- Vital Signs**
PULSE	56	Y	• FHIR Observation • FHIR Condition	See the following implementation guides: **- Vital Signs**
URINE TEST/URINALYSIS	57	Y	See [12] for more details.	
ELECTROCARDIOGRAM	58	Y	• FHIR Observation • FHIR Procedure • FHIR DiagnosticReport • FHIR Media DICOM WEB	

Using EHR data with Form 8500-8 is feasible from a technical standpoint, particularly since medical imaging data is not needed. Using EHR data to examine a patient's diagnostic history and confirm existing exam evaluations could be both effective and efficient uses of FAA resources. This is not dissimilar to the current AME process and could be a form of burden reduction on applicants, AMEs, and FAA by decreasing the need for follow-up confirmations.

Health Level 7 International (HL7) developed a standards framework for exchanging electronic healthcare information known as the FHIR (Health Level Seven International, n.d.). SMART was created to standardize APIs for the use of EHRs across applications (Prolifics, n.d.). Together, SMART on FHIR provides a standard method for handling data and security in healthcare applications (SMILE Digital Health, n.d.). There have been many successes to date with SMART on FHIR app development, resulting in a growing ecosystem of third-party products available in common app stores that can interface with healthcare organizations (KMS Healthcare, 2022). Many of these apps demonstrate workflows that populate medical forms. Fetching data to MedXPress should be similarly practicable.

[14] Opthamology was an early adopter and participant in the development of the FHIR protocol; While it is unclear at this time how much of the opthamology market has adopted FHIR, it is well modeled and documented; The **Eyes on FHIR** and **Eye Care** implementation guides contain details on eye care and eye exams using FHIR.

SMART on FHIR apps could also be used to verify the accuracy of previously submitted Form 8500-8 data. A rule-based or algorithm validation process could use the EHR to check the consistency of a pilot's reported medical history, verify the presence or absence of specific medical conditions, and ensure overall data accuracy. However, the technical feasibility of using EHR data does not reflect the myriad challenges associated with operationalizing that data for use by the FAA or specifically in conjunction with Form 8500-8, as discussed in the Challenges and Key Considerations section below.

Automatic Certification

Automatic certification refers to a future system where applicants could be receive a medical certification without visiting an AME in-person, as currently required by FAA medical standards. Provided automatic certification (or auto-certification) is allowable in the future, vendors already support the data protocols needed for successful implementation.

The functionality itself is similar to an application for a credit card, which includes a credit history check and algorithms to determine credit limit based on credit history. Fetching data to complete form items in Form 8500-8 and verify applicants do not have disqualifying conditions or DNI medications is technically feasible. The interoperability protocols are intended to reduce manual data collection and review for typical applicants, and the systems can electronically perform the same (or similar) workflow and responses as a paper application. Eliminating wait times by enabling the system to automatically certify users that meet approved rulesets (i.e., no disqualifying conditions) is a question of policy and liability, not one of technology.

Depending on the chosen architecture, such functionality will likely involve implementing additional security. Ideally, the MedXPress website or Form 8500-8 application would accept EHR data sent in real-time, such as through the FHIR Subscriptions API. Alternatively, the system can intermittently poll EHR data, or having the pilot initiate a re-application are both workflows that could accomplish the desired goal of reducing delays for medical certification approval.

Special Issuances

AMEs cannot issue medical certificates to persons with disqualifying medical conditions (Federal Aviation Administration). Instead, the Federal Air Surgeon may, at their discretion, grant a special issuance medical certificate (Federal Aviation Administration). Under a special issuance, which is typically granted after a thorough review of the individual's medical history and current health status, individuals who would not normally meet the standard medical requirements are still able to operate aircraft or manage air traffic operations under specific conditions or limitations. Special issuances are derived from FAA policies that have been developed over decades of regulatory experience. These policies can be expressed in decision making rules and clinical decision support algorithms that an applicant uses when filling out Form 8500-8. The rules are also used when the FAA or their designee receives and reviews the Form 8500-8, and when the FAA is reviewing airman readiness and health in follow-up exams and recertifications. Regardless of when they are used, translation of special issuance policies into clinical decision support algorithms begins with mapping special issuance policies to medical terminologies, using SNOMED, LOINC, RxNorm, and other value sets and code systems used by FHIR.[15]

[15] See Appendix G: Terminology Codes for a complete list of terminology codes associated with Special Issuances.

Once mapped into FHIR terminologies and data schemas, these policy rules can be applied to data that is fetched from an EHR, obtained from a pilot's smartphone PHR, or otherwise received via health information exchanges (HIE) or other qualified health information networks (QHIN). When applying these rules, they will typically be used as a filter or as a match list, which can then trigger an event.

Once the initial workflow for a medical examination is developed, it can be applied daily (or weekly, or even monthly) to determine adherence to a special issuance requirement (such as keeping A1C levels in normal ranges). The same API, rule sets, and algorithms would be used; they would just be applied at a different frequency. Instead of a one-time retrieval of data from the hospital, the FAA systems would fetch data on a recurring basis (daily or weekly). Alternatively, FHIR supports a Subscription API, which would allow FAA to automatically receive a notification from 3rd-party systems that an applicant's health data has been updated. At time of publication, the FHIR Subscriptions API is not yet widely supported.

Recertification

Airman who seek recertification after a medical procedure, such as a stent, often face a significant burden in ensuring medical information is complete and accurate. Commercial pilots are often assisted by private document preparation agencies or labor representation to ensure necessary information is included for FAA review, whereas private pilots may receive limited or no support. Recertification documentation prepared by applicants or their physicians may often lack pertinent information, and FAA may request additional information upon review to ensure conditions are stable and non-recurrent. This can lead to long wait times where applicants may not be able to operate aircraft, may lose employment opportunities, or otherwise suffer as they attempt to receive a medical certificate.

Using applicant EHR data can ensure that airmen and their physicians are appropriately notified of necessary tests or information needed for recertification. Integration with EHR systems may also allow FAA to alert of upcoming expiration of certification status or medical tests, such as an EKG which may no longer be applicable before the next certification renewals. This can enable airman to proactively ensure their information is complete and accurate and that necessary exams or documentation from physicians have been scheduled in time to minimize disruption caused by recertification or certification renewal. When insufficient information is provided, either through existing means or via incomplete medical data, EHR systems can allow FAA medical examiners and review boards to request information from EHR data rather than applicants (and thus avoid long wait times). Finally, EHR integration could allow applicants/FAA to automatically prepare compliant recertification or special issuance paperwork when applicable or upon a clinically significant event.

Challenges and Key Considerations

Despite the technical feasibility of using EHR data to electronically populate Form 8500-8, the FAA will still encounter challenges related to data location, availability (including quality), format, ownership, volume, terminologies, structure, privacy laws, security and trust networks, FAA policymaking, and variable state and municipal regulations. These challenges persist even if popular specifications and methods are used. Many of these challenges apply to both the use and validation of Form 8500-8 information.

Technical

Data Location

While the FHIR specification supports all required Form 8500-8 data elements, the location of a pilot's health data in each EHR will be an ongoing area of uncertainty. One of the biggest challenges in capturing and validating EHR data for Form 8500-8, assuming relevant providers are using EHRs, will be determining each source where the necessary data could be available. Pilots and other stakeholders must be forthcoming in providing their AME or the FAA with a complete list of their medical procedures, medications, treatment plans, visits, and providers. Some of this information may already be present in applicant medical claims or insurance information, but while this is not functionally different from the current certification process, which also requires pilots disclose this information, it will continue to be a challenge in the use of EHR data.

Data Availability and Quality

As stated, to complete Form 8500-8, the locations of relevant health data (from a healthcare provider perspective) must first be properly identified. Once that is accomplished, the necessary data to complete the fields in Form 8500-8 must also exist, which depends on the completeness of data being fetched from the originating healthcare system, clinicians who generated the data, and in some cases, which information was also self-reported by the patient. There is also no single method, standard, or framework to assess the data quality of EHRs and best practices are still being formulated (Lewis, AE, Weiskopf, N, Abrams, ZB, Foraker, R, Lai, AM, Payne, PR, Gupta, A, 2023).

Specifically, there may be limitations in using EHRs to retrieve older information in a patient's history. Though EHR systems were developed in academia as early as the 1960s and 1970s, widespread use did not begin until after 2000. Healthcare systems generally have obligations to migrate their databases and keep records for at least 7 years for adults, and 17 years for pediatrics. Most healthcare systems will have records as far back as their installation of EHR systems, and on a patient basis, whenever the patient first sought care in their system. Laboratories were among the early adopters of electronic records systems and may have data as far back as the 1980s. Most labs, however, have not adopted FHIR, so their data availability with respect to FHIR is related to what is mapped and migrated by their associated healthcare systems. There is also no legal requirement to store lab records past 2 years (10 years for pathology). Overall, the landscape is fragmented, with some institutions having decades of information and others doing the legal minimum. Older data may also require fees to access.

Data Format

Data format, referring to the way data elements are stored, may be a concern in the FAA's use of EHR data. Unlike the table-based data used by the current MedXPress SQL database, EHR data will often be transmitted from document-oriented databases such as the Massachusetts General Hospital Utility Multi-programming System (MUMPS) (Defense Technical Information Center), Caché (InterSystems Corporation), MongoDB, or Oracle JSON Document Database. These systems are likely to send data as either documents of free-form narrative text (such as PDFs), and/or via deeply nested tree structures in XML or JSON. Free-form narrative text is challenging to model into structured formats and difficult to analyze because of information volume and writing style (Asanka, D., 2020).

Data Transfer

HL7 publishes implementation guides that are relevant to the use of EHR data for populating Form 8500-8 via the MedXPress website and/or other FAA systems. Implementation guides specify

processes for integrating EHR within a healthcare organization and contain important API documentation and architecture guides for vendors. In addition to documenting items such as API calls, data schemas, value sets, and sequence diagrams, they provide examples of the data to be sent over the wire. This document can then be used for verification of API endpoints and validation of expected data transfer.

Data Ownership

Use of EHR data to satisfy Form 8500-8 requirements will not require FAA to have unfettered access to pilots' health records. Further, applicants' health records will not be required to be incorporated into any FAA systems. Rather, the FAA can develop a solution to generate data to support certification based on EHR data that would remain in its original location. The FAA will need to carefully message this intended approach to avoid confusion and concern amongst its stakeholders.

Data Volume (Marker Dynamics / Scale Out)

There are approximately 17,890 Federally Qualified Healthcare Centers (FQHCs) in the US that accept Medicare and Medicaid payments, including hospitals, clinics, nursing homes, and other health centers. Any software application seeking to acquire data from these centers must be registered with each individual FQHC. The FAA could do this itself by registering with FQHCs of highest interest. This would effectively create an in-house Health Information Exchange (HIE) (The Office of the National Coordinator for Health Information Technology (ONC), n.d.) or Qualified Health Information Network (QHIN). Alternatively, the FAA could use existing popular distribution mechanisms, such as app stores, to leverage health aggregator systems such as Apple Health or CommonHealth. Appendix F: Medical Data Integration from Other Sectors and Industries contains a guide to medical data integration from other sectors and industries.

Data Terminologies

The MedXPress website, other FAA systems, and related FAA business processes, such as the requirement that pilots provide detailed clinical progress notes, currently use ICD-10 codes (Federal Aviation Administration, 2022). Although ICD-10 is supported in FHIR, EHR vendors more commonly standardize data using SNOMED (SNOMED International, n.d.) and Logical Observation Identifiers Names and Codes (LOINC) codes (LOINC from Regenstrief, n.d.). SNOMED and LOINC have taken steps towards ensuring interoperability with each other (Regenstrief Institute, Inc. and SNOMED International, n.d.). Much of the data provided by healthcare systems may not be available in ICD format. Supporting FHIR in MedXPress may necessitate purchasing a SNOMED license; LOINC requires registration but does not require a license to use. To access all the major EHR providers, FAA systems and procedures may need to support ICD-9, ICD-10, and SNOMED.

Data Structure

MedXPress and Form 8500-8 currently model data structures slightly differently than SNOMED. Certain Form 8500-8 questions may be represented as combined responses in SNOMED, and some Form 8500-8 questions with a single response may be modeled more granularly in SNOMED. For example, eyesight codes and heterophoria are liable to exhibit different structures in the two clinical coding types. These could impact medical certification information such as eyeglass prescriptions and annual reports. To map ICD-10 codes in MedXPress to SNOMED EHR codes, a data management process like a reporting crosswalk would be needed between the two to ensure data consistency.

Certain data elements will also require the FAA to decide how to receive this information. Two examples are listed below. More will likely surface during the cross walk and configuration process.

- **Systolic vs Diastolic Blood Pressure -** The FHIR specification has a specific way to model blood pressure, which is supported by the major EHR vendors, but is significantly different than how the MedXPress website currently stores those values (Health Level 7 International, n.d.). Notably, blood pressure is considered a multi-component observation in FHIR. Implementors will not only need to parse a tree-structure of data but will also need to parse through an array to get to the relevant systolic/diastolic measurements.
- **Sex vs Gender** - EHR data is liable to have significantly more granular data around sex and gender than are currently being recorded in FAA systems (McClure, R., 2023). EHR data supports male/female codes that can map directly onto existing MedXPress codes; however, the codes will exist in a gender field, rather than a sex field. Additionally, some systems may support extended value sets with values in addition to male and female. Importantly, the gender field is presently interpreted as the current patient gender. A *sexAssignedAtBirth* extension can be provided within the patient resource since biological sex is often key to properly interpreting medical information relevant to sex, especially as needed for forecasting safety risk. The FAA will likely have decision points around how to handle the incoming data and how it will be mapped and merged with prior sex/gender models.

Security and Trust Networks

Security and trust networks are an emerging option for stakeholders to fetch EHR data, particularly if the FAA would like AMEs to perform that function. Participating in a Trusted Exchange Framework and Common Agreement (TEFCA)-approved QHIN requires a number of additional security components, similar to HIPAA, including (but not limited to) NIST 800-171 compliant servers (Ross R., Pillitteri V., November 2023), participating in the TEFCA Common Agreement (The Office of the National Coordinator for Health Information Technology (ONC), n.d.) (similar to a HIPAA Business Associate Agreement), OAuth 2.0 implementation (OAuth 2.0, n.d.), X.509 security certificates (SSL.com, 2019) (similar to SSL certificates), security labels, and more.

Domain Names and Certificates

The existing MedXPress domain and certificate infrastructure are sufficient to navigate the EHR and App Store registration processes. However, using existing domains and certificates will create a tightly coupled system where downtime, maintenance, or a security breach on one part will affect all components in the system. For reasons related to maintenance, scalability, modularity, and analytics reporting, it is generally advised to register any mobile apps, including a future Form 8500-8 SMART on FHIR app, on separate sub-domains, and generate additional security certificates unique to those sites.

Operations and Policymaking

Legal Frameworks

Using EHR data to enable information collection in MedXPress will involve regulatory oversight on several levels. The relevant regulatory frameworks that need to be considered during decision making processes include the Privacy Act of 1974 (United States Department of Justice), the 21st Century Cures Act (114th Congress of the United States of America, 2016), the CARIN Alliance – Code of Conduct (CARIN Alliance, n.d.), and the TEFCA (The Office of the National Coordinator for Health Information Technology (ONC), n.d.). The Health Insurance Portability and Accountability Act (HIPAA) (Centers for Disease Control and Prevention, n.d.) does not currently apply to the medical data used by the FAA as the agency is not a covered entity (U.S. Department of Health

and Human Services, n.d.). In addition, some of the data on Form 8500-8 may have state-level restrictions or approval processes that complicate data availability.

The successful use of EHR data to complete and validate Form 8500-8 will require conversations with stakeholders about policies and procedures. This engagement is necessary to completely understand user workflows and subsequent challenges the use of this data may create for those currently involved in the generation of Form 8500-8 data in MedXPress.

To leverage data from the many distribution networks (HIEs, QHINs, Apple Health, App Stores, etc.), the FAA will need to enter legal relationships with the various networks and vendors. Although the FAA has decades of experience protecting pilot privacy in the context of the 1974 Privacy Rule, any past experiences with Request For Proposals (RFPs) or negotiating customized Business Associate Agreements under HIPAA are unlikely to apply. Rather, when setting up needed information sharing infrastructure, the FAA may find itself navigating streamlined registration process by vendors and health information exchange networks which do not vary significantly or allow for customization or modification. During registration with their programs, various legal documents may be requested, the most important of which is the Privacy Policy for the MedXPress or relevant websites, and any contractors responsible for operating such systems. There will likely be no opportunity for the FAA to negotiate such agreements with FAA counsel. Rather, FAA policymaking will substantially need to occur before any attempts to register apps or services with the EHR vendors or associated app stores.

Research Opportunities

Despite the challenges identified in the previous section, EHR data can assist with AAM's safety assurance, special issuance, and recertification processes.

- EHR data can assist in safety assurance practices, such as determining the effectiveness of the AME exam in capturing accurate medical information and identifying pilots who may be at risk of operating aircraft while impaired or incapacitated. The AME exam may suffer from applicant non-disclosure of relevant medical information for several reasons:
    - Pilots not understanding the side-effects of medications they are taking that could impact their ability to operate the aircraft
    - Applicants not understanding all the symptoms that present with a condition
    - Applicants under-appreciating the severity of a medical condition and thinking it is irrelevant to the questions being asked
    - Pilots not disclosing a medical condition that is well-managed on the ground, and not understanding how a change in altitude or pressure might aggravate that condition.
    - Applicants not aware of existing medical condition, believing in a self-diagnosed condition, or mis-diagnosed
- EHR data is well suited to supporting special issuances because of the granular data involved and the possibility of continuous health condition monitoring and interventions. The nature of FHIR-based API access to pilot EHR data means that applicants can consent to sharing their data on an ongoing basis. That data can then be used to verify ongoing compliance to special issuance requirements, such as taking certain medications for heart conditions or use of consumer medical devices to track and manage conditions such as diabetes or sleep apnea.

- EHR data can also help recertify applicants through automatic fetching of data, and fast-tracking eligible applicants who have not had any major health events since their last certification. Interoperability protocols are designed to update data electronically. Algorithms and rule-based protocols could be developed to validate previous Form 8500-8 data submissions against updated EHR information, creating a differential diagnosis and way to quickly identify changes since the prior examination.
- Data availability and connecting to multiple health systems is a Six-Sigma problem. Market adoption of interoperability protocols is currently approximately one-sigma and is expected to increase over the upcoming years. Although adoption is uneven across the country, the FAA may pursue a multi-year rollout and give immediate attention to conducting pilot programs in areas of the US that have high adoption rates and/or a list of preferred providers who have validated their EHR systems are interoperable and useful for FAA needs.

  Research opportunities during such a pilot program may consider the following:

  - Multiple stakeholders
  - Multiple workflows with varying levels of user experience requirements
  - Self-service workflows, agent/examiner workflow, etc.
  - Personal health records and digital wallets (digital credit card holders such as Apple Wallet can also contain health information, such as insurance cards and vaccine credentials) relevant to aeromedical certification
  - Smart assistants and personal AI algorithms

Conclusions

- From the perspective of data feasibility/available information/administrative need, the current FAA MedXPress website is an appropriate candidate to integrate with healthcare organizations' EHR systems. SMART on FHIR offers a write-once, deploy-anywhere solution.
- PHRs such as Apple Health or Common Health act as health data aggregators and are likely to be among the most effective approaches to gathering the necessary longitudinal data needed to complete Form 8500-8.
- EHR vendors such as Epic and Oracle Cerner operate 'app stores' that allow 3rd parties to register apps and help coordinate distribution among the major US healthcare systems. Of the 3,876 short-term acute care hospitals in the US, in 2022 the Office of the National Coordinator concluded that Epic had a 36% market share, and Oracle Cerner had a 24.9% share; for a total of 60% of the market served by this duopoly, which roughly aligns with ONC's assessment that 2 in 3 hospitals report using a FHIR API to enable patient access to data in 2022. This was an increase of 12% from the year before, and at those rates of adoption, current estimates are now in the 70% to 85% range.
- While FAA certification workflows are not completely unique, and there are many similar services in the overall healthcare landscape, the stakeholders involved in populating data for the FAA needs will likely want and need different workflows. FHIR APIs are designed to substantially support many of these patient-first, clinician-first, or specialist-first workflows.

Recommendations

- Make a policy determination to continue with the current Form 8500-8 or to revise the form to collect additional or different data. This research presents an opportunity to consider whether

Form 8500-8 collects the most useful information for the purpose of medical certification and special issuance. As the use of EHR data matures, and the availability of items such as medical images increases, the FAA may wish to consider the role and usage of different or higher fidelity data such as medical imaging in future iterations of its certification processes. Additionally, while human physiology is a useful and natural cognitive model for the examiner, other approaches of structuring Form 8500-8 may streamline the collection of medical history – such as organizing the form along clinical specialties, or with data standards such as the International Patient Summary.

- Develop a concept of operations for medical certification, special issuance, and safety assurance that takes advantage of the EHR data, such as the use of continuous monitoring.
- Explore methods to incentivize pilots to provide complete medical histories using EHR data. Offering faster processing times for medical recertifications and special issuances would likely be effective incentives.
- Consider the needs of each stakeholder and related workflow involved in the population of Form 8500-8 (see Appendices A and I) in terms of scale-out paths or roadmaps. Some workflows will be more costly and complex than others, and resource prioritization that aligns with those needs is advantageous.
- Become familiar with the implementation guides created by HL7 (Health Level 7 International, n.d.) and encourage or require future upgrades of the MedXPress website and other FAA systems to include EHR data fetch functionality according to these resources.
- Engage organizations who may be able to access EHR data on the FAA's behalf. EHR vendors, the mobile app stores, and HIEs have delivery channels that can mitigate the burdens of integrating EHR data into MedXPress and connecting FAA systems to the necessary healthcare systems. This may require new business relationships, new contracts, and new processes.
- Although the FAA may be familiar with the 1974 Privacy Rule and HIPAA, new regulations such as the 21st Century Cures Act and TEFCA will introduce new regulatory burdens and opportunities. FAA will benefit from legal consultation during any potential RFP process regarding the Privacy Policy and being attentive that the privacy policy is up to date and accurately reflects current implementations. The EHR vendors will have limited tolerance for inaccuracies or negotiations, and such matters will need to be addressed prior to filing or registering with them.
- Articulate an ideal end state for the incorporation of EHR data in MedXPress and how that would best be used to support specific business needs such as safety assurance, special issuances, or recertification.
- Ensure that FAA and contractor development teams have the skills required for operational development and sustainment, either through hiring or retooling. For example, architecture requirements for EHR workflows may require programmers with a different skill set than prior contractors on MedXPress. Additionally, different workflows for different stakeholders may require different skillsets (e.g., HIPAA/TEFCA implementation will require more database/security development, while 21st Century Cures access for pilots using PHRs will require more mobile app development).

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Appendix A: Use Cases

To help visualize the future state of using EHR data to support the medical certification process, the figure below depicts at a high level the expected interactions between the AMEs, pilots, clinicians, various health systems, and the HIE critical for pulling and pushing data to FAA systems, such as MedXPress. Note that the use of wearable devices and remote monitoring capabilities is deemed out of scope but should be of interest to FAA for future enhancement.

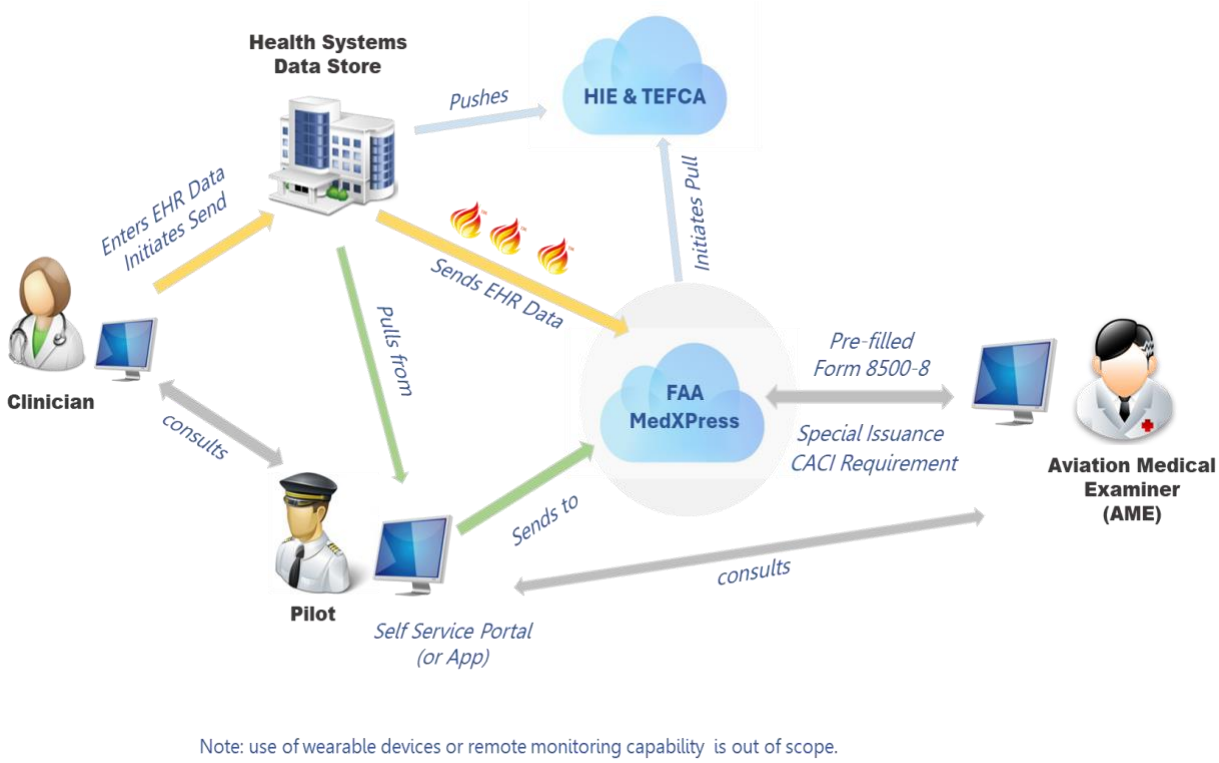

Figure 2. High level Future State Interactions.

Use cases and scenarios applicable to medical certification are summarized in Table 3. For each use case, the following attributes were used to highlight the different challenges associated with these scenarios:

- **Initiator** - The individual(s) initiating the certification process
- **Business model** - High-level description of the workflow that will be used to generate Form 8500-8
- **Data Storage** - Location where the data used to populate Form 8500-8 will be gathered from
- **Legal** - Legal framework of data ownership the workflow is operating under
- **Architecture** - System architecture for the application or website
- **Constraints / Prerequisites** - Implementation considerations such as scalability, deployment, and feasibility

Table 3. Use Case Summary.

Use Case	Initiator	Business Model	Data Storage	Legal	Architecture	Constraints / Prerequisites
UC1: Pilot Self-Service Workflow – Patient Portal **UC3: Pilot Self-Service Workflow – Personal Health Records**	Pilot	Self service	EHR	21st Century Cures Act	WebApp with patient portal launch	FAA, contractors, or business partners need to register MedXPress app with 17,000 hospitals or clinics
UC2: Clinician Sends Pilot Record to Examiner	Clinician	Clinical consults	EHR	HIPAA	WebApp with EHR launch	FAA, contractors, or business partners need to register MedXPress app with 17,000 hospitals or clinics
UC3: Pilot Self-Service Workflow – Personal Health Records	Pilot	Self service	PHR	21st Century Cures Act	Mobile app	Must register with Apple and/or Android App Stores
UC4: Pilot Uses Stand-Alone MedXPress with OAuth	Pilot	Self service	EHR	HIPAA; 21st Century Cures	WebApp with OAuth data fetch	FAA, contractors, or business partners need to register MedXPress app with 17,000 hospitals or clinics
UC5: Medical Examiner Initiates Data Fetch - Routine Certification Exam UC5: Medical Examiner Initiates Data Fetch - Routine Certification Exam	AME	Clinical consults	QHIN	TEFCA	WebApp with QHIN lookup	TEFCA agreement, similar to a BAA
UC6: Medical Examiner Initiates Data Fetch – Special Issuance or CACI Requirement Lookup	AME	Clinical consults	QHIN	TEFCA	WebApp with QHIN lookup	TEFCA agreement, similar to a BAA

UC1: Pilot Self-Service Workflow – Patient Portal

Business Model	Data Storage	Legal	Architecture
Self-Service	EHR	21st Century Cures Act	Webapp Patient Portal Launch

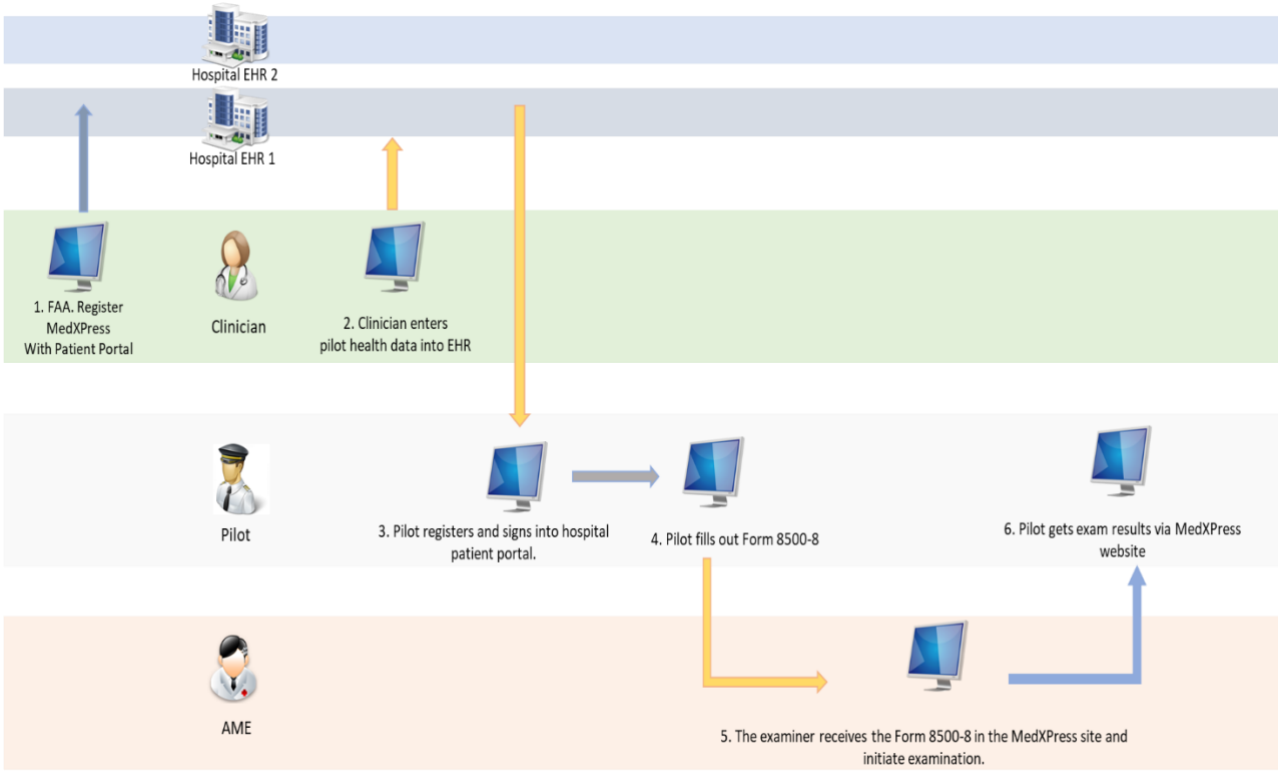

Figure 3. Pilot Self-Service Workflow - Patient Portal

Description

Pilot needs to certify and begins by creating account in self-service website, enters basic demographic information then logs into the patient portal. Pilot selects the MedXPress link from 'External Apps' menu choice and then clicks 'send.' The patient portal sends the pilot's medical data to MedXPress where it is then matched against a data dictionary and pre-fills forms. The pilot reviews the filled-out forms in MedXPress, adds extra information as needed, then submits the form which is then available for the AME to review.

Prerequisites

FAA, contractors, or business partners need to register the MedXPress app with over 17,000 federally qualified health centers and look-alikes (i.e., hospitals and clinics) (Workgroup, 2023).

UC2: Clinician Sends Pilot Record to Examiner

Business Model	Data Storage	Legal	Architecture
Clinical Consults	EHR	HIPAA	Webapp with EHR Launch

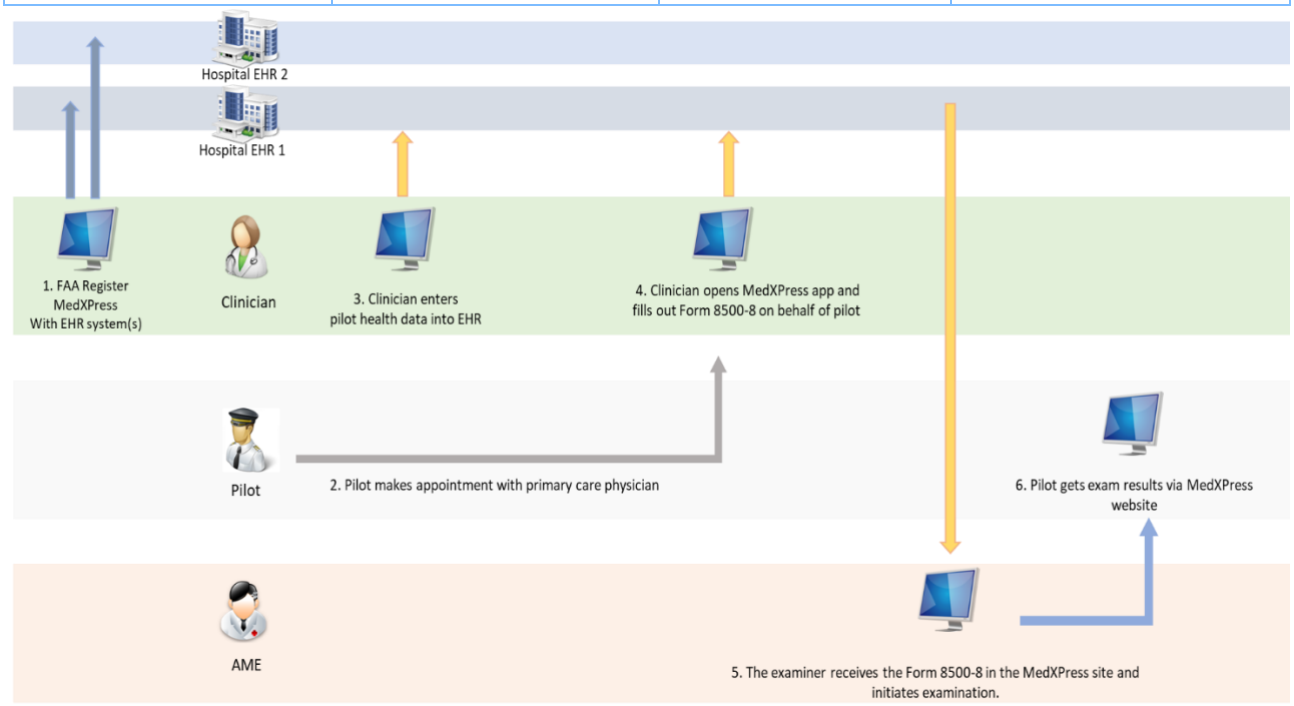

Figure 4. Clinician Sends Pilot Records to Examiner Workflow

Description

A pilot needs to certify and begins by scheduling an appointment with their primary care provider (i.e., Clinician). The pilot arrives at the office and discusses certification process with healthcare provider. The clinician opens up EHR, selects the pilot's medical record, clicks on the 'Open in FAA Examination App.' The app opens and fetches the medical record based on the clinician's login credentials, then matches against data-dictionary and pre-fills the form accordingly. The clinician reviews the filled out forms, adds extra information as needed then sends it to either the pilot or the AME can view the information in MedXpress to the AME.

Prerequisites

FAA, contractors, or business partners need to register the MedXPress app with over 17,000 federally qualified health centers and look-alikes (i.e., hospitals and clinics) (Workgroup, 2023).

UC3: Pilot Self-Service Workflow – Personal Health Records

Business Model	Data Storage	Legal	Architecture
Self Service App Store	PHR	21st Century Cures Act	Mobile App

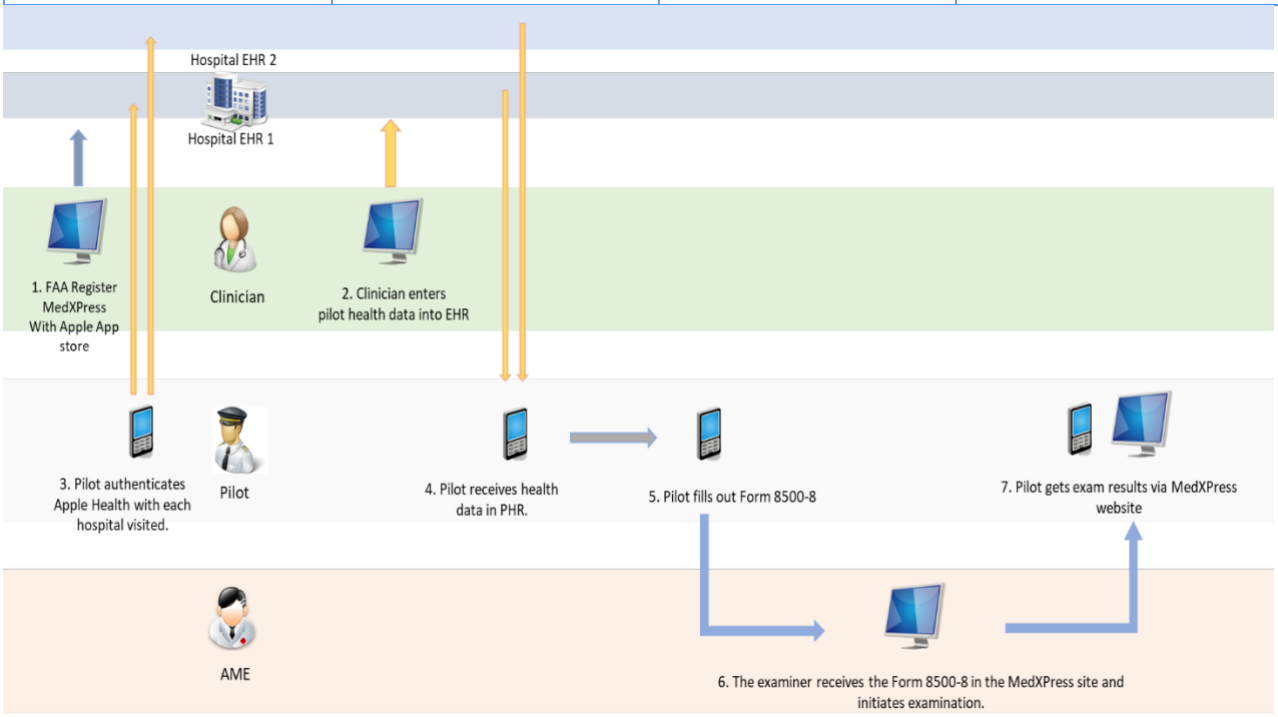

Figure 5. Pilot Self-Service Workflow - Personal Health Records

Description

A pilot needs to certify and begins by downloading a Pilot Recertification App. The app asks the pilot to begin setting up a Personal Health Record (PHR) such as Apple Health. The PHR asks for basic demographic information and then offers a list of medical providers that participate in the Apple Health HIE (e.g., Mayo Clinic, Kaiser Permanente, Walgreens, NY Presbyterian, Quest Diagnostics). The pilot signs into the desired services using their patient portal information, and the PHR begins synchronizing data to the pilot's smartphone. The Pilot Recertification app then queries the PHR data store, matches patient history against a data-dictionary, and pre-fills the form the best it can. The pilot then reviews the filled-out form from within the app, adds extra information, and submits the form. The app then sends it to the AME.

Prerequisites

FAA, contractors, or business partners need to register the MedXPress app with a patient data aggregator service, such as Apple Health, Common Health, or a health information exchange. Pilots need to sign into each provider with their patient portal login information.

UC4: Pilot Uses Stand-Alone MedXPress with OAuth

Business Model	Data Storage	Legal	Architecture
Self Service App Store	PHR	21st Century Cures Act	Mobile App

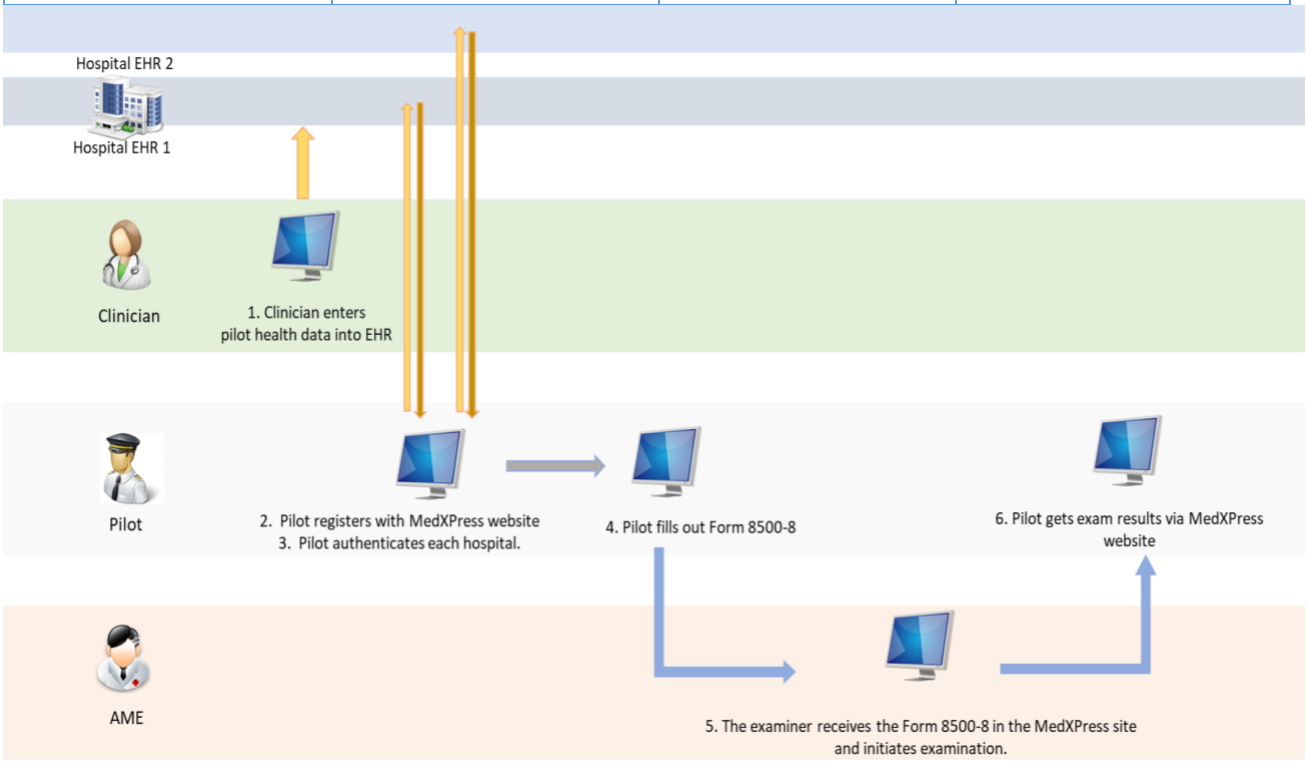

Figure 6. Pilot Uses Standalone Website with OAuth Authentication

Description

A pilot needs to certify and begins by creating an account in the MedXPress self-service website and fills out basic demographic information. A list of medical providers is provided (e.g., Mayo Clinic, Kaiser Permanente, Walgreens, NY Presbyterian, Quest Diagnostics). The pilot selects the 'Sign in with...' item and selects a provider and enters patient portal sign-in information. The self-service website fetches medical history from the 3rd party based on login credentials, matches the data against a data-dictionary, and pre-fills forms accordingly. The pilot reviews the filled out forms, adds extra information, then sends it to the AME.

Prerequisites

FAA, contractors, or business partners need to register the MedXPress app with over 17,000 federally qualified health centers and look-alikes (i.e., hospitals and clinics) (Workgroup, 2023). Pilots will need to sign into each healthcare provider using their patient login information.

UC5: Medical Examiner Initiates Data Fetch - Routine Certification Exam

Business Model	Data Storage	Legal	Architecture
Clinical Consults	QHIN	21st Century Cures Act	WebApp with QHIN lookup

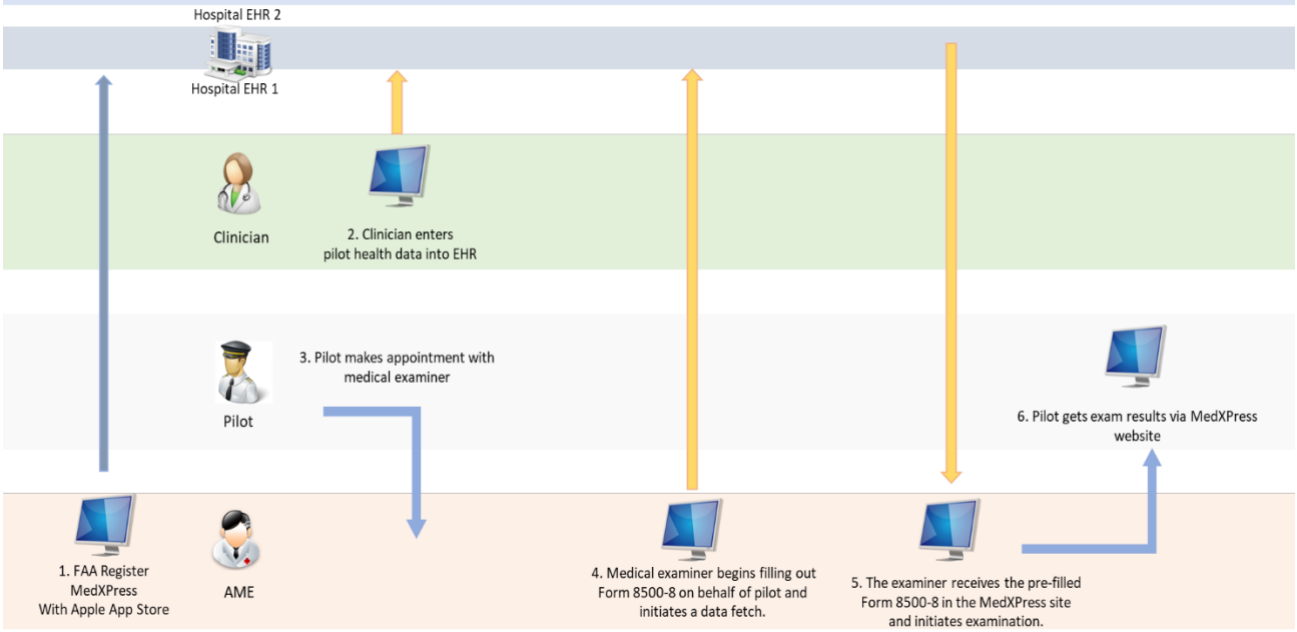

Figure 7. Medical Examiner Initiates Data Fetch Workflow

Description

A pilot needs to certify and begins by scheduling an appointment with an AME. The pilot arrives at the AME's office and discusses certification process. The AME searches a health information exchange (HIE) for the pilot's data and initiates a fetch. The HIE matches the records against a data dictionary and pre-fills the form accordingly. The AME reviews the filled out forms, adds extra information as needed, then sends results back to the pilot.

Prerequisites

FAA, contractors, or software implementors enter into business-associate-agreements (BAA) with Trusted Exchange Framework and Common Agreement (TEFCA) approved Qualified Health Information Network (QHIN), such as eHealth Exchange, Epic Nexus, Health Gorilla, or others.

UC6: Medical Examiner Initiates Data Fetch – Special Issuance or CACI Requirement Lookup

Business Model	Data Storage	Legal	Architecture
Clinical Consults	QHIN	21st Century Cures Act	WebApp with QHIN lookup

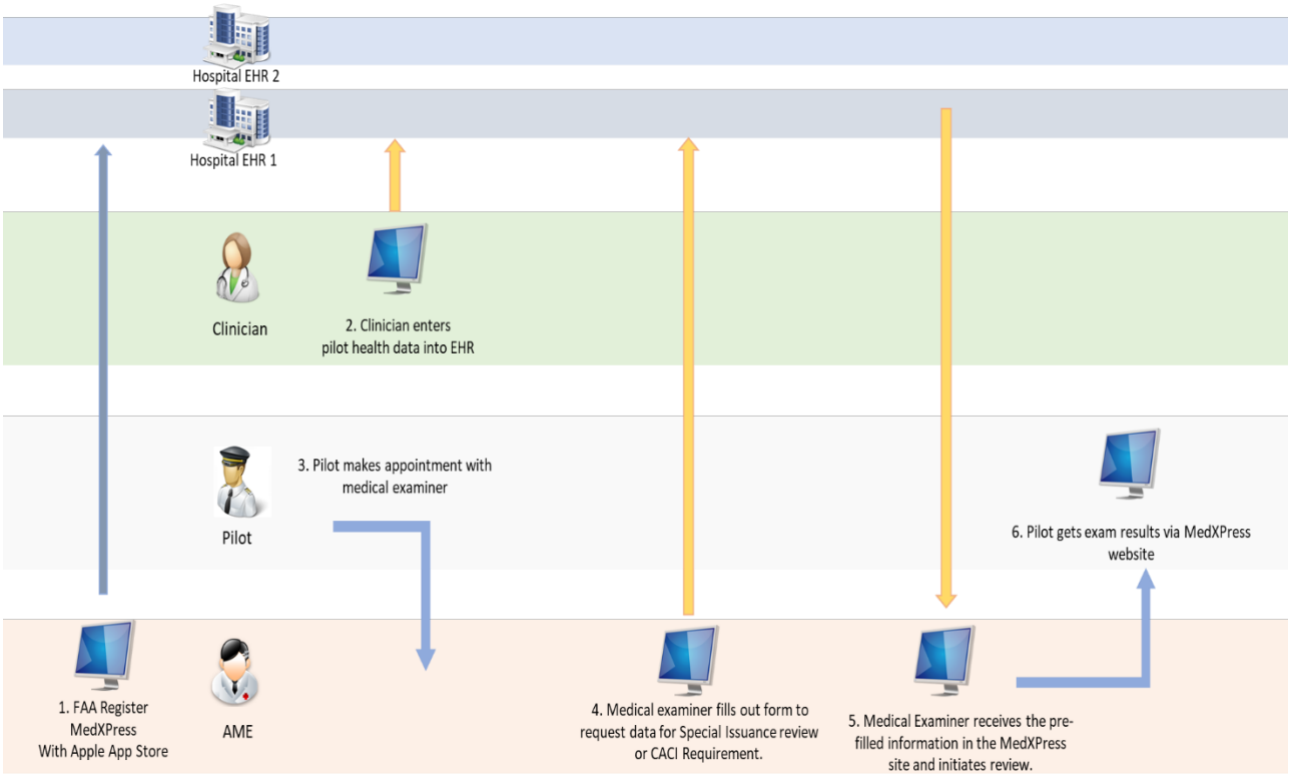

Figure 8. Medical Examiner Initiates Data Fetch for Special Issuance or CACI Workflow

Description

A pilot needs to certify and begins by scheduling an appointment with an AME. The pilot arrives at the AME's office and discusses certification process. The AME searches a HIE for the pilot's data and initiates a fetch related to Special Issuance or CACI requirement. The HIE then matches the data against a data dictionary and pre-fills the form accordingly. The AME reviews the filled-out form, adds extra information as needed, then sends the results back to the pilot.

Prerequisites

FAA, contractors, or software implementors enter into business-associate-agreements (BAA) with Trusted Exchange Framework and Common Agreement (TEFCA) approved Qualified Health Information Network (QHIN), such as eHealth Exchange, Epic Nexus, Health Gorilla, or others.

Appendix B: Legal Frameworks

Leveraging EHR data in MedXPress to facilitate pilot medical certification will involve regulatory oversight on several levels. The relevant regulatory frameworks needing consideration during decision making include those described in the table below.

Frameworks for Consideration	Relevance to FAA
Privacy Act of 1974 (United States Department of Justice) The Privacy Act of 1974 governs the collection, maintenance, use, and dissemination of personally identifiable information in systems of records by federal agencies, including medical information. Under this act, the Department of Transportation (DOT) and the Federal Aviation Administration (FAA) proposed the "DOT/FAA 856 Airmen Medical Records" system, which specifically addresses the handling of medical records for airmen.	This system aligns with the regulations in 14 CFR 61.23, which outlines the requirements and duration for medical certificates necessary for pilots.
Health Insurance Portability and Accountability Act (HIPAA) HIPAA mandates guidelines for handling protected health information (PHI), which includes a) securing user accounts and passwords to prevent unauthorized access, b) maintenance of comprehensive audit logs to monitor access and changes to PHI, and c) enforcement of robust encryption standards, both for data in transit (over the wire) and stored data (at rest), to protect sensitive information from interception or breaches. Compliance with HIPAA extends to the development and implementation of detailed policy and procedure manuals that outline the proper handling of PHI. Furthermore, HIPAA necessitates business associate agreements (BAA), which are contracts ensuring that all parties handling PHI adhere to HIPAA's stringent privacy and security requirements. Implementation Constraints: • Multi-user systems • Single-user accounts • Encryption at rest • Encryption over the wire • Policies and Procedures • Roles and Responsibilities Audit logs • Audit logs	Relevant to medical data that the FAA itself generates during its employment of medical personnel that have provider/patient relationships with staff, crew, or passengers.
21st Century Cures Act (114th Congress of the United States of America, 2016) The 21st Century Cures Act, significant legislation in the United States, primarily aims to accelerate medical product development and bring new innovations and advances to patients who need them faster and more efficiently. A key aspect of this Act is the emphasis on patient rights to access their own health information conveniently and securely, empowering individuals in their healthcare journey. It mandates the use of standardized application programming interfaces (APIs) to ensure that health systems can communicate seamlessly, thereby enhancing interoperability and accessibility of health data. To enforce these provisions, the Act includes stringent measures against information blocking practices, imposing fines and penalties on entities that deliberately impede the sharing or access of electronic health information. These components of the 21st Century Cures Act collectively work towards a more transparent, patient-centered healthcare system, fostering greater engagement and collaboration between patients, healthcare providers, and technology developers. Implementation Constraints: • Standard interoperability protocol and data schemas (FHIR) • Authorization mechanisms (OAuth, SMART on FHIR)	Provides the right for a patient to access their own health data, and do what they wish with it; including sharing with 3rd parties or publicly publishing it. Enables 'bring your own health data' business models and personal health record ecosystems.
CARIN Alliance – Code of Conduct (CARIN Alliance, n.d.) A commerce-initiated endeavor in response to the 21st Century Cures Act. Because the 21st Century Cures bypasses the regulator oversight of HIPAA and does not require a Business Associate Agreement and associated safeguards of vendors who act on patient's behalf; the industry has established a voluntary Code of Conduct and ethics statement that vendors can opt into. Implementation Constraints: • Privacy Policy Language	Code of Conduct for 3rd party vendors building services relying on 21st Century Cures. Inspired by HIPAA requirements.

Frameworks for Consideration	Relevance to FAA
TEFCA – Trusted Exchange Framework and Common Agreement (The Office of the National Coordinator for Health Information Technology (ONC), n.d.) An initiative in the United States aimed at creating a unified framework for health information exchange across different networks. Developed by the Office of the National Coordinator for Health Information Technology (ONC), its goal is to enable secure and interoperable exchange of health information nationwide. TEFCA focuses on providing a single "on-ramp" for any healthcare provider, regardless of size or technological capability, to join the network, aiming to improve patient access to their medical records and enhance the efficiency of the healthcare system. It establishes common principles, terms, and conditions to support the development of a health information network that is inclusive, trusted, and reduces the burden on healthcare providers. Implementation Constraints: • SSL Certificate Authority/Registration • User Identification • HL7 FHIR / CDA	Akin to a health information exchange highway. Streamlines the HIPAA Business Associate Agreement (BAA) into a standard process, and creates a trust network of HIPAA compliant public-private partnership participants.

Appendix C: Sample EHR Vendor Data Use Questionnaire

The following questionnaire is utilized by Epic Corporation when registering a SMART on FHIR application. The FAA (and any supporting contractors) needs to be prepared to complete the following questionnaire. This questionnaire is used to collect required information as well as to determine which functionalities in the FHIR APIs of Epic systems, the different workflows, and user interfaces should be enabled. Some answers may disqualify the application altogether and result in a rejected application. Some answers will establish different legal positions and result in different legal agreements into which the parties enter. Additionally, while Epic has formalized and automated this data use discovery discussion into a structured questionnaire, these questions pertain to any/all EHR systems. Other EHR vendors such as Oracle Cerner and Allscripts may not provide this exact type of online data questionnaire functionality, but it should be expected that they will seek to understand and collect information on these topics or ask substantially similar questions via one-on-one conversations.

Which option best describes the company offering the app to users/patients?

- A healthcare provider.
- Government agency.
- Non-profit organization.
- For-profit organization.
- An individual or independent developer.

How is this app funded? (Select all that apply.)

- This app is funded by a healthcare provider.
- This app is funded by purchases, subscriptions, or donations.
- This app is funded by advertisements.
- This app is funded by the sale of the user's data or access to other organizations.
- This app is funded by your other business ventures.
- This app is funded by debt or venture capital in a startup company.
- This app is produced by volunteers or is available in the open-source community.
- This app is funded by grants from:

Where does this app store user data? (Select all that apply.)

- This app can store user data locally on the user's device.
- This app can store user data in locations outside of the user's control.
- This app offers users an option to store data in locations outside of the user's control.
- This app stores data in locations outside of the user's control.
- This app does not store user data.

Other than the user, who has access to user data? (Select all that apply.)

- No one; data never leaves the user's device.
- Your staff.
- People and groups users authorize.
- Apps that users authorize.
- The user's care team.
- Researchers.
- Your partners or affiliates.
- Government employees or agencies.
- Others:

Does the app developer allow users to obtain a complete record of the data that has been collected about them?

- Yes, users can obtain a complete record of the data that has been stored about them.
- No, users can obtain only a partial record of the data that has been stored about them.
- No, users cannot obtain a record of the data that has been stored about them.

Does the app developer use data about a user for reasons other than providing direct services to the user?

- No, the app developer doesn't use data about users beyond providing direct services.
- The app developer may use data about users to improve its services in the future.
- The app developer may use data about users for research.
- The app developer may use data about users for advertising to users.
- The app developer may use data about users to allow third parties to advertise to users.
- The app developer may use data about users for advertising to others.
- The app developer may provide, distribute, or sell data about users to other parties.
- The app developer app may sell aggregate, generalized, or de-identified data about users to third parties.

What other individuals from the user's health record does the app use data about beyond providing direct services? (Select all that apply)

- No one.
- The user's care team.
- The user's family.
- The user's healthcare proxy.

Does this app allow users to obtain a complete record of who has accessed data about them?

- Yes, this app allows users to obtain a complete record of who has accessed data about them.
- No, this app allows users to obtain only a partial record of who has accessed data about them.
- No, this app does not allow users to obtain a record of who has accessed data about them.

Is user data retained after a user deletes the app and closes their account?

- Yes.
- No.

Appendix D: SNOMED Codes and Sample Query URLs

Table 4. Selected SNOMED Codes

Question	Category	Description	URL
Q5_ZIP_CODE			/Patient/id={patientId}
Q6_AGE_AT_EXAMINATION			/Patient/id={patientId}
Q9_SEX			/Patient/id={patientId}
Q17_HAS_ANY_MEDICATIONS			/MedicationDispense?patient={patientId}
Q17_CURRENT_MEDICATIONS			/MedicationRequest?patient={patientId}
Q17_USE_CONTACTLENS_FLYING			
Q18_18A	Neurological	**Tension-type headache** 398057008	/Condition?code=398057008
Q18_18A	Neurological	**Migraine** 37796009	/Condition?code=37796009
Q18_18A	Neurological	**Chronic tension-type headache** 230471006	/Condition?code=230471006
Q18_18A	Neurological	**Chronic daily headache** 458241000124102	/Condition?code=458241000124102
Q18_18A	Neurological	**Cluster headache** 193031009	/Condition?code=193031009
Q18_18A	54012000	Posttraumatic headache	/Condition?code=54012000
Q18_18A	79267007	Retinal migraine	/Condition?code=79267007
Q18_18B	69096003	Dizziness	/Condition?code=69096003
Q18_18B	271594007	Syncope	/Condition?code=271594007
Q18_18C	69944003	Unconscious	/Condition?code=69944003
Q18_18C	418107008	Unconscious	/Condition?code=418107008
Q18_18D	371405004	Disorder of eye	/Condition?code=371405004
Q18_18F	195967001	Asthma	/Condition?code=195967001
Q18_18F	13645005	Chronic obstructive lung disease	/Condition?code=13645005
Q18_18G	128238001	Chronic heart disease	/Condition?code=128238001
Q18_18G	8957000	Conary artery disease	/Condition?code=8957000
Q18_18G	49436004	Atrial fibrillation	/Condition?code=49436004
Q18_18H	38341003	Hypertensive disorder	/Condition?code=38341003
Q18_18H	75367002	Blood pressure	/Condition?code=75367002
Q18_18H	45007003	Low blood pressure	/Condition?code=45007003
Q18_18I	328383001	Chronic liver disease	/Condition?code=328383001
Q18_18J	34436003	Blood in urine	/Condition?code=34436003
Q18_18J	95570007	Kidney stone	/Condition?code=95570007
Q18_18K	73211009	Diabetes mellitus	/Condition?code=73211009
Q18_18L	84757009	Epilepsy	/Condition?code=84757009
Q18_18L	91175000	Seizure	/Condition?code=91175000
Q18_18L	230690007	Cerebrovascular accident	/Condition?code=230690007
Q18_18L	44695005	Paralysis	/Condition?code=44695005
Q18_18M	74732009	Mental disorder	/Condition?code=74732009
Q18_18M	47505003	Posttraumatic stress disorder	/Condition?code=47505003
Q18_18M	35489007	Depressive disorder	/Condition?code=35489007
Q18_18M	48694002	Anxiety	/Condition?code=48694002
Q18_18N	66214007	Substance abuse	/Condition?code=66214007
Q18_18N	394642008	Drug screening test	/Condition?code=394642008
Q18_18O	66590003	Alcohol dependence	/Condition?code=66590003

Q18_18O	15167005	Alcohol abuse	/Condition?code=15167005
Q18_18P	82313006	Suicide Attempt	/Condition?code=82313006
Q18_18Q	37031009	Motion sickness	/Condition?code=37031009
Q18_18U	32485007	hospital admission	/Condition?code=32485007
Q18_18X	387713003	Surgical procedure	/Condition?code=387713003
Q18_18X	21134002	Disability	/Condition?code=21134002
Q19_HAS_HEALTH_VISITS_LAST_3YEARS			/Encounter?date=ge2021-01-01
Q19_HEALTH_VISITS_FREQUENCY			/Encounter?date=ge2021-01-01
Q21_HEIGHT	1153637007	Body height	/Observation?code=1153637007
Q22_WEIGHT	27113001	Body weight	/Observation?code=27113001
Q23_SODA			
Q23_DEFECT_NOTED			
Q49_CONV_VOICE_6FT			
Q49_SPEECH_DISCR_SCORE			
Q49_RIGHT_EAR_500			
Q49_RIGHT_EAR_4000			
Q49_LEFT_EAR_500			
Q49_LEFT_EAR_4000			
Q50_DISTANCEVISION_RIGHT	246633000	Distance vision	/Observation?code=246633000,24028007
Q50_DISTANCEVISION_RIGHT_CORRECTED	246633000	Distance vision	
Q50_DISTANCEVISION_LEFT	246633000	Distance vision	/Observation?code=246633000,7771000
Q50_DISTANCEVISION_LEFT_CORRECTED	246633000	Distance vision	
Q50_DISTANCEVISION_BOTH	246633000	Distance vision	/Observation?code=246633000,24028007,7771000
Q50_DISTANCEVISION_BOTH_CORRECTED	246633000	Distance vision	
Q51A_NEARVISION_RIGHT	830128004	Near vision	/Observation?code=830128004,24028007
Q51A_NEARVISION_RIGHT_CORRECTED	830128004	Near vision	TBD
Q51A_NEARVISION_LEFT	830128004	Near vision	/Observation?code=830128004,7771000
Q51A_NEARVISION_LEFT_CORRECTED	830128004	Near vision	TBD
Q51A_NEARVISION_BOTH	830128004	Near vision	/Observation?code=830128004,24028007,7771000
Q51A_NEARVISION_BOTH_CORRECTED	830128004	Near vision	TBD
Q51B_INTERMEDIATEVISION_RIGHT			
Q51B_INTERMEDIATEVISION_CORRECTED			
Q51B_INTERMEDIATEVISION_LEFT			
Q51B_INTERMEDIATEVISION_LEFT_CORRECTED			
Q51B_INTERMEDIATEVISION_BOTH			
Q51B_INTERMEDIATEVISION_BOTH_CORRECTED			
Q52_COLOR_VISION	271726001	Color vision	/Observation?code=271726001
Q53_FIELD_VISION			
Q54_HETEROPHORIA20_ESOPHORIA	62176008	Esophoria	/Observation?code=62176008
Q54_HETEROPHORIA20_EXOPHORIA	46343005	Exophoria	/Observation?code=46343005
Q54_HETEROPHORIA20_HYPERPHORIA_RIGHT	421452007	Hyperphoria	/Observation?code=421452007,24028007

Q54_HETEROPHORIA20_HYPERPHORIA_LEFT	421452007	Hyperphoria	/Observation?code=421452007,7771000
Q55_BLOODPRESSURE_SYSTOLIC	75367002, 271649006	Blood pressure	/Observation?code=75367002,271649006
Q55_BLOODPRESSURE_DIASTOLIC	75367002, 271650006	Blood pressure	/Observation?code=75367002,271650006
Q56_PULSE_RESTING	8499008	Pulse, function	/Observation?code=8499008
Q57_URINE_ABNORMAL			
Q57_URINE_ALBUMIN	271000000	Urine albumin measurement	/Observation?code=271000000
Q57_URINE_SUGAR	170755004	Urine sugar chart	/Observation?code=170755004
Q58_ECG_DATE	54550000	Electroencephalogram	/Observation?code=54550000
Q59_OTHER_TESTS_GIVEN			
Q60_COMMENTS_HISTORY_FINDINGS			
Q60_SIGNIFICANT_MEDICAL_HISTORY			
Q60_ABNORMAL_PHYSICAL_FINDING			
Q63_DISQUALIFYING_DEFECTS			

In practice, these queries will likely be combined into aggregate queries against the FHIR endpoints, as illustrated below.

Fetch patient demographics for a specific patient
https://hospital.org/fhirR4/Patient?id={patientId}

Fetch all medical encounters for a specific patient from Jan 1st, 2020 onward
https://hospital.org/fhirR4/Encounter?patient={patientId}&date=ge2020-01-01

Fetch personal characteristics for a specific patient
https://hospital.org/fhirR4/Observation?code=1153637007,27113001&patient={patientId}

Fetch all Form-8500-8 conditions for a specific patient
https://hospital.org/fhirR4/Condition?code=398057008,37796009,230471006,458241000124102,193031009,54012000,79267007,69096003,271594007,69944003,418107008,371405004,195967001,13645005,128238001,8957000,49436004,38341003,75367002,45007003,328383001,34436003,95570007,73211009,84757009,91175000,230690007,44695005,74732009,47505003,35489007,48694002,66214007,394642008,66590003,15167005,82313006,37031009,32485007,387713003,21134002&patient={patientId}

Fetch all Form 8500-8 clinical observations for a specific patient
https://hospital.org/fhirR4/Observation?code=271726001,62176008,46343005,421452007,421452007,75367002,75367002,8499008,271000000,170755004,54550000&patient={patientId}

Fetch all Form 8500-8 vital signs for a specific patient
https://hospital.org/fhirR4/Observation?code=8499008,75367002,271649006,271650006,54550000&patient={patientId}

Appendix E: Sample FHIR Observation – Blood Pressure

To illustrate the usage of the FHIR APIs, we provide an example of how EHRs model the blood pressure measurements in a significantly different manner than the current Form 8500 collects it. When the FHIR API is queried for SNOMED code 75367002, as described below, the healthcare EHR servers will respond with a JSON object like the following data structure:

Fetch all Blood Pressure observations for a specific patient
https://hospital.org/fhirR4/Observation?code=75367002&patient={patientId}

Note that both the systolic and diastolic values are contained within a single resource that uses a multi-component measurement. Implementors will need to navigate the use of hierarchical tree-like data structures (specifically, the JSON and XML data formats) to parse the needed values from the returned data. This is because the EHR systems do not return simple tabular or spreadsheet like data, such as is common with SQL systems. Decision makers should be broadly aware of the difference in the incoming data from EHRs and understand that its incorporation may require upskilling workers to use these data structures.


```
{
  "resourceType" : "Observation",
  "id" : "BloodPressurePanel-example",
  "meta" : {
    "profile" : [
      "http://hl7.org/fhir/us/vitals/StructureDefinition/blood-pressure-panel"
    ]
  },
  "status" : "final",
  "category" : [
    {
      "coding" : [
        {
          "system" : "http://terminology.hl7.org/CodeSystem/observation-category",
          "code" : "vital-signs",
          "display" : "Vital Signs"
        }
      ],
      "text" : "Vital Signs"
    }
  ],
  "code" : {
    "coding" : [
      {
        "system" : "http://loinc.org",
        "code" : "85354-9",
        "display" : "Blood pressure panel with all children optional"
```

```
      }
    ]
  },
  "subject" : {
    "display" : "Small Child1234"
  },
  "effectiveDateTime" : "2019-10-16T12:12:29-09:00",
  "issued" : "2019-10-16T12:12:29-10:00",
  "performer" : [
    {
      "display" : "A. Pediatrician6"
    }
  ],
  "bodySite" : {
    "coding" : [
      {
        "system" : "http://snomed.info/sct",
        "code" : "723961002",
        "display" : "Structure of left brachial artery (body structure)"
      }
    ]
  },
  "device" : {
    "reference" : "Device/BPDevice1-example"
  },
  "component" : [
    {
      "code" : {
        "coding" : [
          {
            "system" : "http://loinc.org",
            "code" : "8480-6"
          }
        ]
      },
      "valueQuantity" : {
        "value" : 120,
        "unit" : "mm[Hg]",
        "system" : "http://unitsofmeasure.org",
        "code" : "mm[Hg]"
      }
    },
    {
      "code" : {
        "coding" : [
          {
            "system" : "http://loinc.org",
            "code" : "8462-4"
```

```
            }
          ]
        },
        "valueQuantity" : {
          "value" : 80,
          "unit" : "mm[Hg]",
          "system" : "http://unitsofmeasure.org",
          "code" : "mm[Hg]"
        }
      }
    ]
}
```

Appendix F: Medical Data Integration from Other Sectors and Industries

A scan of the commercial marketplace for mature healthcare EHR platforms and applications revealed Epic and Cerner as the major players in this sector with Epic having 35.9% in the US hospital market share and Oracle Cerner with 24.9%. With regards to percentage of US hospital beds, Epic has 47.6% and Cerner has 25.8%. The third highest market share is Meditech.

Epic App Orchard

Epic was founded first, has focused on the largest and most complex hospital systems, uses unique documented-oriented databases, and is generally considered to support the greatest number of patient records. Epic used the 21st Century Cures Act as an opportunity to develop the 'App Orchard,' a marketplace of apps modeled after the Apple App Store. Epic has since replaced that marketplace with Connection Hub (Epic, 2022).

Applications	Relevance to FAA
• Auto Clinical Summary – A chart review tool which provides a summary of the patient's history that allow providers to familiarize themselves with the patient • Krames on FHIR – Patient Portal Integration – Offers patient education at the point of care or via a patient portal. Based on the patient's profile, the attending clinician can suggest appropriate video or printed content therefore tailored to the patient's needs • Delfina Care - Platform used for pregnancy care; Features include provider dashboards (an EPIC embedded data visualization tool for review of self-reported patient biometrics such as weight, blood pressure, glucose, etc.), remote patient monitoring devices capability, and built in predictive models	Examples of 3rd party websites and services that fetch data from hospital EHRs via SMART on FHIR interfaces, allow patients to initiate workflows from their patient portals, and collect and report biometric data.

Cerner Code

Of the major EHR vendors, Epic has the larger market share of hospital systems, but Cerner has the greater number of overall installations, when outpatient clinics and specialty practices are included. Additionally, Cerner holds several important federal contracts, such as with the Veterans Administration (Landi, H., 2023). Cerner relies on the Oracle database which supports document-oriented columns but is fundamentally more of a spreadsheet-everywhere model (Oracle Cerner, n.d.).

Applications	Relevance to FAA
• MyDirectives – Provides healthcare providers the latest patient's advance care planning documents; It allows the patients to create, store, update, and share digital or printed versions of these documents with their providers or authorized 3rd parties; For patients who do not have an advance care plan, the providers can send an email or text invitations via the app • Evidently - Indexes and summarizes content from both structed and unstructured records using its proprietary cognitive AI tool; This tool is programmed to recognize medical concepts (e.g., lab results, medications, diagnosis, procedures) and the relationships between these disparate datasets • Propeller – Digital health platform that is able to track patients with asthma or chronic obstructive pulmonary disease medication dosage and usage trends via Bluetooth sensors; The data is	Examples of 3rd party websites and services that fetch data from hospital EHRs, summarize the data, and fill out forms on behalf of the patient.

integrated with Cerner which allows their care team to monitor, identify, and prioritize patients at higher risk of hospitalization	

Apple App Store

By volume and market share, the Apple App Store is the largest digital goods and services market on the planet, with App Store developers generating $1.1 trillion in total billings and sales in the ecosystem in 2022.

Applications	Relevance to FAA
• MaxMD – An app that allows for secure messaging between providers and patients as well as capability to access and manage patient medical documents and resources	Example of a mobile app, distributed through the Apple ecosystem, and receiving EHR data via Apple Health, a patient data aggregator.

Google Play

Google Play is the app store platform from Google for the Android phone system.

Applications	Relevance to FAA
• Epic MyChart - Portal that allows patients to retrieve their health information such as appointments, health history, visit summaries, medications, and test results as well as billing information; The portal also allows both patients and their care teams to communicate securely via secure messaging and connect wearables (e.g., Google Fit) to pull health related data that can be incorporated into their own health records • eClinicalWorks Mobile - Allows providers to view their patients' records through their smart phones or other handheld devices; Providers can also access schedules, write prescriptions, and review encounters via a secure gateway	Examples of mobile apps in the Android ecosystem that fetch patient data from hospital EHRs via SMART on FHIR interfaces. eClinicalWorks has been in the business of developing clinical kiosks for many years, similar to the passenger check-in kiosks in use by airlines.

CARIN Alliance: My Health Application

CARIN Alliance has created a niche application directory listing, that focuses on consumer health applications that exercise rights under the 21st Century Cures Act.

Applications	Relevance to FAA
• CommonHealth – The Android equivalent of Apple health Data aggregator which allows patients to collect and manage their data then share it with their care team (such as health systems or provider organizations) and trusted apps • Vet mHealth – Intended for veterans and authorized caregivers to gather their health information from the Veterans Administration (VA) systems, medical devices, and wearables; This allows the veterans to enter their health measurements and self-report that can be shared with their providers and care team	Examples of cross-platform SMART on FHIR apps that leverage the 21st Century Cures Act and have adopted the CARIN Alliance Code of Conduct as a trust mechanism instead of HIPAA or TEFCA. Also includes example apps used by other federal agencies (specifically the Veterans Administration) to fill out forms and enact workflows similar to the Form 8500-8 process.

• DBQ Pro – Assists veterans through the disability claim process by allowing veterans to collect supporting medical evidence through user friendly workflow and prompts	

Appendix G: Terminology Codes

Using EHR data to complete Form 8500-8 will require enumerating the medical terminology codes for the conditions, procedures, medications, and other aspects relevant to medical fitness for flying. The primary terminology systems that EHRs use are **SNOMED** (Systematized Nomenclature of Medicine – Clinical Terms), **LOINC** (Logical Observation Identifiers, Names, and Codes), **RxNorm** (medical prescription normalization), and to a lesser extent, **ICD-9** and **ICD-10** (International Classification of Diseases), and **DSM-V** (Diagnostic and Statistical Manual of Mental Disorders).

The qualifying or contraindicated codes will need to be enumerated for each use case, workflow state, or special issuance. Examples of special issuance condition and procedure codes, do-not-fly medications, and do-not-issue medications are provided below.

Special Issuance Condition Codes (SNOMED CT)

Osteoarthritis (disorder)	396275006
Psoriasis (disorder)	9014002
Asthma (disorder)	195967001
Atrial fibrillation (disorder)	49436004
Malignant neoplasm of urinary bladder (disorder)	399326009
Malignant neoplasm of breast (disorder)	254837009
Malignant neoplasm of colon (disorder)	363406005
Coronary arteriosclerosis (disorder)	53741008
Diabetes mellitus type 2 (disorder)	44054006
Glaucoma (disorder)	23986001
Viral hepatitis, type A (disorder)	40468003
Hyperthyroidism (disorder)	34486009
Hypothyroidism (disorder)	40930008
Non-Hodgkin's lymphoma (disorder)	118601006
Hodgkin's disease (disorder)	118599009
Malignant melanoma (disorder)	372244006
Migraine (disorder)	37796009
Mitral valve regurgitation (disorder)	48724000
Congestive heart failure (disorder)	42343007
Neurofibromatosis type 1 (disorder)	92824003
Obstructive sleep apnea syndrome (disorder)	78275009
Paroxysmal atrial tachycardia (disorder)	195069001
Prediabetes (finding)	714628002
Overweight (finding)	238131007
Obese (finding)	414915002
Malignant tumor of prostate (disorder)	399068003
Kidney stone (disorder)	95570007
Malignant tumor of kidney (disorder)	363518003
Malignant tumor of testis (disorder)	363449006
Malignant tumor of ovary (disorder)	363443007
Thrombocytopenic disorder (disorder)	302215000

Special Issuance Exam Codes (LOINC)

Laboratory

Hemoglobin A1c/Hemoglobin.total in Blood:	4547-6

CBC Auto Differential panel in Blood by Automated count:	69742-5
Alpha-1-Fetoprotein [Mass/volume] in Serum or Plasma:	83073-7
Choriogonadotropin.beta subunit [Units/volume] in Serum or Plasma:	19180-9
Thyrotropin [Units/volume] in Serum or Plasma:	3016-3
Thyroxine (T4) free [Mass/volume] in Serum or Plasma:	3024-7

Radiology

XR Chest and Abdomen Views:	42269-1
CT Abdomen and Pelvis:	44115-4
CT Abdomen and Pelvis W contrast IV:	36813-4
CT Abdomen and Pelvis with WO contrast:	36952-0
MR Abdomen:	24556
MR Abdomen WO and W contrast IV	24557-1
US Heart Transesophageal:	85475-2
Ultrasound Kidney:	38036-0

Special Issuance Medications (RXCUI)

Albuterol:	435
Metformin:	860975
Canagliflozin:	1373458
Empagliflozin:	1545653
Dapagliflozin:	1488564
Liraglutide:	475968
Semaglutide (Oral):	1991302
Dulaglutide (Injectable):	1551291
Methimazole:	6835
Propylthiouracil:	8794
Levothyroxine:	10582
Sumatriptan:	37418
Propranolol (for prevention):	8787
Erenumab (CGRP inhibitor):	2045613
Modafinil (for daytime sleepiness):	30125
Flecainide:	4441
Atenolol:	1202
Metformin (for Prediabetes):	6809
Prednisone (for corticosteroids):	8640

Do Not Fly Medications (RXCUI)

Diphenhydramine (Benadryl):	3498
Chlorpheniramine (Coricidin; ChlorTrimeton):	2400
Alprazolam (Xanax):	596
Lorazepam (Ativan):	6470
Temazepam (Restoril):	10355
Triazolam (Halcion):	10767
Carisoprodol (Soma):	2101
Cyclobenzaprine (Flexeril):	21949
Morphine:	7052
Codeine:	2670
Oxycodone (Percodan, Oxycontin):	7804
Hydrocodone (Lortab, Vicodin, etc.):	5489
Tramadol (Ultram):	10689
Diphenhydramine (as a sleep aid):	3498

Kava-Kava: Not available in RxNorm due to its status as a supplement.
Kratom: Not available in RxNorm due to its status as a supplement.
Valerian: Not available in RxNorm due to its status as a supplement.

Do Not Issue Medications (RXCUI)

Nitrates (Nitroglycerin):	4917
Isosorbide Dinitrate (Imdur):	6058
Ranolazine (Ranexa):	35829
Atropine:	1223
Tolterodine (Detrol):	119565
Oxybutynin (Ditropan):	32675
Solifenacin (Vesicare):	322167
Benztropine (Cogentin):	1424
Pramlintide (Symlin):	139953
Bromocriptine (Cycloset, Parlodel):	1760
Pramipexole (Mirapex):	746741
Ropinirole (Requip):	72302
Rotigotine (NeuPro):	616739
Clonidine:	2599
Methyldopa:	6876
Reserpine:	9260
Mefloquine (Lariam):	6694
Prednisone:	8640
Phentermine (Adipex):	8152
Sertraline:	36437
Lorazepam:	6470
Risperidone:	35636
Methylphenidate:	6901
Lithium Carbonate:	42351
Amphetamine/Dextroamphetamine:	725
Diazepam:	3322
Levetiracetam:	114477
Bupropion + Naltrexone (Contrave):	42347

Appendix H: Form 8500-8

See the Application History portion of the FAA Aviation Medical Exam website for more information on the fields requested as part of the Form 8500-8 in MedXpress.