Unifying Healthcare Information Systems in Taiwan: A Strategy for Promoting Health Equity and Global Collaboration

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EHR is the foundation of contemporary medical practice

EHR is the foundational platform supporting today's healthcare delivery, connecting providers, patients, and public health systems to improve outcomes.

Although 100% paperless, Taiwan's EHR systems lacks interoperability

Inadequate

Interoperability

How EHR Interoperability Gaps Widen Health Disparities for underserved population

- Underserved Patients have more frequent transfers than urban patient

- Remote area is dependent on telemedicine & wearables

- Lab test of underserved area patients may need to send to hospitals

- Advanced Image Exam alo has to be conducted in hospitals

NHI of Taiwan developed My Health Bank and MediCloud

However, these data are not FHIR compatible and cannot integrate into HIS
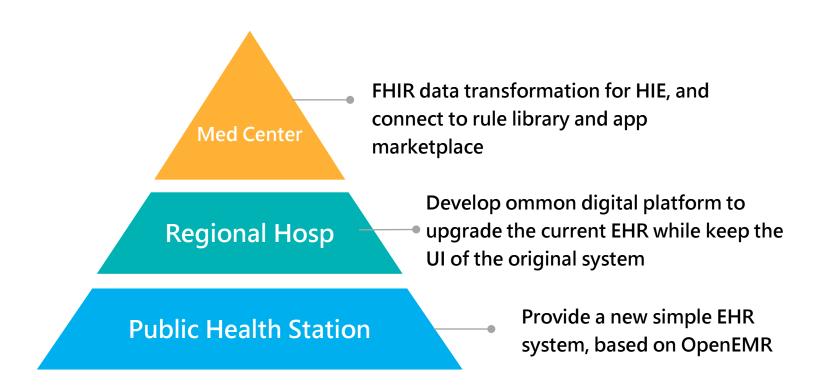
Defining NextGen EHR in Taiwan: Three Key Features

Rule Library

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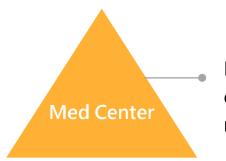
Strategy for 3 tiers Hospitals

Med Center — FHIR data transformation for HIE, and connect to rule library and app marketplace

Regional Hosp — Develop ommon digital platform to upgrade the current EHR while keep the UI of the original system

Public Health Station — Provide a new simple EHR system, based on OpenEMR

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Strategy for 3 tiers Hospitals

Med Center

FHIR data transformation for HIE, and connect to rule library and app marketplace

TWCDI V0.1

Allergies and Intolerances (過敏及不耐受)
- Substance – Medication
- Substance - Drug Class
- Substance – Non Medication
- Reaction

Care Team Members (護理團隊成員)
- Care Team Member Name
- Care Team Member Identifier
- Care Team Member Role
- Care Team Member Location
- Care Team Member Telecom

Clinical Notes (臨床記錄)
- Consultation Note
- Discharge Summary Note
- History & Physical
- Procedure Note
- Progress Note

Clinical Test (臨床測試)
- Clinical Test
- Clinical Test Result/Report

Diagnostic Imaging (診斷影像)
- Diagnostic Imaging Test
- Diagnostic Imaging Report

Encounter Information (就診資訊)
- Encounter Type
- Encounter Identifier
- Encounter Diagnosis
- Encounter Time
- Encounter Location
- Encounter Disposition

Facility Information (設施資訊)
- Facility Identifier
- Facility Type
- Facility Name

Goals and Preferences (目標及偏好)
- Patient Goals
- SDOH Goals
- Treatment Intervention Preference
- Care Experience Preference

Health Insurance Information (健康保險資訊)
- Coverage Status
- Coverage Type
- Relationship to Subscriber
- Member Identifier
- Subscriber Identifier
- Group Identifier
- Payer Identifier

Health Status Assessments (健康狀況評估)
- Health Concerns
- Functional Status
- Disability Status
- Mental/Cognitive Status
- Pregnancy Status
- Alcohol Use
- Substance Use
- Physical Activity
- SDOH Assessment
- Smoking Status

Immunizations (免疫接種)
- Immunizations

Laboratory (實驗室)
- Test
- Values/Results
- Specimen Type
- Result Status
- Result Unit of Measure
- Result Reference Range
- Result Interpretation
- Specimen Source Site
- Specimen Identifier
- Specimen Condition Acceptability

Medical Devices (醫療器材)
- Unique Device Identifier - Implantable

Medications (藥物)
- Medications
- Dose
- Dose Unit of Measure
- Indication
- Fill Status
- Medication Instructions
- Medication Adherence

Patient Summary and Plan (患者摘要/計畫)
- Assessment and Plan of Treatment

Problems (問題)
- Problems
- SDOH Problems/Health Concerns
- Date of Diagnosis
- Date of Resolution

Procedures (處置)
- **Procedures**
- Performance Time
- SDOH Interventions
- Reason for Referral

Patient Demographics/Information (患者人口統計/資訊)
- First Name
- Last Name
- Previous Name
- Date of Birth
- Date of Death
- Race
- Sex
- Sexual orientation
- Gender Identity
- Current Address
- Previous Address
- Phone Number
- Phone Number Type
- Email Address
- Related Person's Name
- Relationship Type
- Occupation
- Occupation Industry

Provenance (出處)
- Author Time Stamp
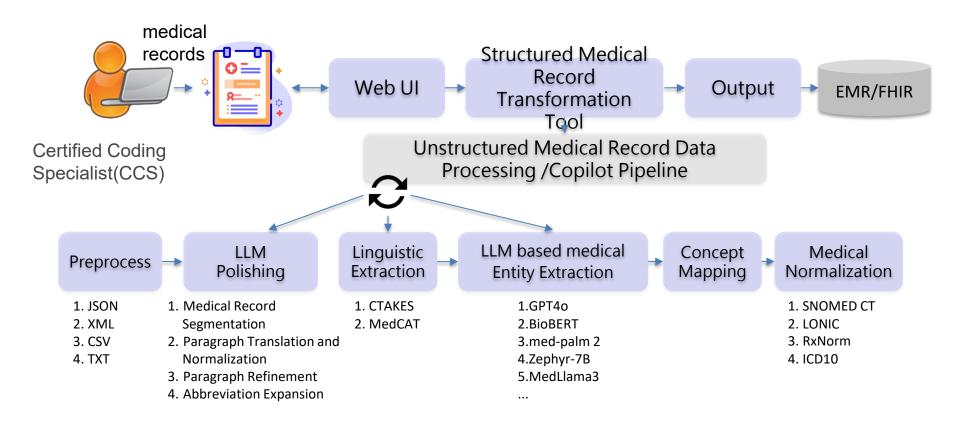- Author Organization

Vital Signs (生命徵象)
- Systolic Blood Pressure
- Diastolic Blood Pressure
- Average Blood Pressure
- Heart Rate
- Respiratory Rate
- Body Temperature
- Body Height
- Body Weight
- Pulse Oximetry
- Inhaled Oxygen Concentration
- BMI Percentile (2 - 20 years)
- Weight-for-length Percentile (Birth - 24 Months)
- Head Occipital-frontal Circumference percentile (Birth - 36 Months)

Internal and External Hospital Data Exchange Tool

FHIR Data Standardization Tool: Batch-upload test data, normalize codes with an LLM-based tool, convert to the FHIR standard via FHIR Converter, and store or exchange on hospital FHIR Servers. Data visualization is enabled through dashboards.

LLM-Based Tool for Unstructured Medical Record Processing

medical records

Web UI

Structured Medical Record Transformation Tool

Output

EMR/FHIR

Certified Coding Specialist(CCS)

Unstructured Medical Record Data Processing /Copilot Pipeline

Preprocess	LLM Polishing	Linguistic Extraction	LLM based medical Entity Extraction	Concept Mapping	Medical Normalization
1. JSON 2. XML 3. CSV 4. TXT	1. Medical Record Segmentation 2. Paragraph Translation and Normalization 3. Paragraph Refinement 4. Abbreviation Expansion	1. CTAKES 2. MedCAT	1.GPT4o 2.BioBERT 3.med-palm 2 4.Zephyr-7B 5.MedLlama3 ...		1. SNOMED CT 2. LONIC 3. RxNorm 4. ICD10

Hospital Information Exchange

We have developed LLM based end to end ETL pipeline

Rule Library

Based on Clinical Quality Language and CDS hook

For prior authorization in health insurance and corss-hospital quality management

| Data Upload and Parsing | Unstructured Data Processing | FHIR Format Conversion | FHIR Data Storage | FHIR Format Validation | FHIR Data Transmission |

A醫院　　B醫院

SMART on FHIR

SMART (Substitutable Medical Apps, Reusable Technologies)

"*FHIR standardizes healthcare data format, while SMART standardizes how applications can request and access this data.*"

衛 生 福 利 部
Ministry of Health and Welfare

A Decade of SMART

2009

NEJM: *No Small Change for the Health Information Economy* – introduces the API

White Paper: "... Fostering Development of an "iPhone-like" Platform..."

iTDotHealth meeting with government, vendors, academia

2010

$15M SHARP grant to the SMART Team

Draft SMART API released (RDF data models)

Cardiac Risk app becomes first SMART app

2011

SMART Apps Contest on Challenge.gov, promoted by White House. First health-related apps challenge

SMART Sandbox launched

2012

BP Centiles: First SMART App in production at Boston Children's Hospital

2013

Release of SMART on FHIR Genomics

SMART team joins FHIR development effort

2014

Release of SMART on FHIR specification

Launch of SMART Advisory Committee with diverse stakeholders committed to SMART on FHIR ecosystem

JASON Task Force report recommends a public API for healthcare

Argonaut project launched to implant SMART in EHRs

2015

2015 EHR certification and meaningful use 3 final rules require patient access via API

Launch of SMART App Gallery

Launch of SMART CDS Hooks, a decision support specification

2016

Precision Medicine Initiative Sync for Science uses SMART API

21st Century Cures Act makes APIs a requirement for certified HIT, incorporating language from the SMART team

Cerner launches SMART on FHIR Developers Sandbox

2017

Allscripts and EPIC launch SMART on FHIR developers sandboxes

Project Argonaut commits to CDS-Hooks Implementation

SMART Team, ONC & HL7 launch the SMART FLAT FHIR bulk data project

Carin Alliance focuses on implementing

2018

Apple adds SMART support to its Health App for patient access to medical data

CMS launches Blue Button 2.0 using SMART for API access to Medicare claims

Dept of Veterans Affairs to incorporate SMART on FHIR support into next-generation EHR platform

CMS pilots SMART bulk data FLAT FHIR export

SMART on FHIR published as an HL7 standard

2019

CMS commits to SMART Bulk Data specs

Microsoft launches SMART on FHIR API in its Azure product

Proposed rules from CMS & ONC specify SMART as the universal apps API to implement 21st Century Cures

3 Cloud vendors at White House commit to SMART and FHIR open APIs

Veterans accessing health records using Apple's SMART on FHIR Health App

2020

Final rule from ONC specifies SMART as the universal apps API to implement 21st Century Cures

SMART Markers Framework for Patient Generated Data

SMART®

Featured Apps
All Apps

▶ **APPLICATION TYPE**
▼ **CATEGORIES**

Care Coordination
Clinical Research
Data Visualization
Disease Management
Genomics
Medication
Patient Engagement
Population Health
Risk Calculation
FHIR Tools
COVID-19
Telehealth

▶ **OS SUPPORT**
▶ **FHIR SUPPORT**
▶ **SPECIALTY**
▶ **PRICING**
▶ **DESIGNED FOR**
▶ **EHR SUPPORT**

Featured Apps 43

Sort: Name (A-Z)

Abstractive Health
Abstractive Health

Abstractive Health is a physician AI assistant that helps you curate the optimal patient record.

View

Designed for: Clinicians

AI-Powered Health Chart App
Prairie Byte Solutions

AI-Powered Health Chart app is a pioneering solution designed to offer physicians an efficient way to access and understand health data.

View

OS: Web   **Specialties:** Primary care   **Designed for:** Clinicians

ASCVD Risk Calculator
Cerner Corporation

The ASCVD Risk Calculator is a tool that estimates a 10-year and/or lifetime cardiovascular risk score and how to potentially reduce risk.

View

Grant for Three Pilot Centers: Goals and Objectives

1. **Collaboration**: Partner with the ITRI to verify ETL (extraction, transformation, loading) tool.
2. **Data Conversion**: Demonstrate seamless data conversion between different hospital systems.
3. **Library Interface**: Confirm that the data can interface with the national 'Healthcare Rules Library'.
4. **SMART Marketplace Access**: Show successful connections to the SMART app marketplace
5. **Data Integration**: Integrate with the personal health record portal with regularly batch uploading of TWCDI data
6. **Demonstration**: Introduce the tool's workflow and education after successful execution of the project

Regional Hosp

Build a common digital platform to upgrade their EHR, UI can customized by vendors

臺灣次世代數位醫療平台 PAUL
Platform Advancing Unified heaLthcare

Android Framework

System Apps

| Dialer | Email | Calendar | Camera | … |

Java API Framework

Content Providers	Managers			
	Activity	Location	Package	Notification
View System	Resource	Telephony	Window	

Native C/C++ Libraries

| Webkit | OpenMAX AL | Libc |
| Media Framework | OpenGL ES | … |

Android Runtime

Android Runtime (ART)

Core Libraries

次世代數位醫療平台之共通規劃

醫療應用

| HIS 醫療資訊系統 | NIS 護理資訊系統 | SMART APP | PACS 醫療影像管理系統 | CDSS 臨床決策支持系統 | 健康管理平台 | 遠程醫療服務 | … |

System Apps (和醫療相關的共通模組)

| EMR/EHR 電子病歷 | FHIR Service | SMART app launch | CDS Hooks 管理 | 用戶認證 | 健保申報 | Calendar 排程預約 | 跨醫院資料交換 | … |

API framework

| FHIR API | CDS Hooks Discovery & CRUD | SMART on FHIR API | EMR API | 沙盒 | Rule Engine | … |

SDK

| 資安主動防禦 系統資訊與稽核軌跡彙整API | AI/GAI LLM/數據分析/影像分析SDK |
| 零信任資安防護 零信任架構介接SDK | UIUX UIUX SDK | 沙盒 SDK |

Docker/Kubernetes（K8s）

軟體服務模組與框架

| AI/GenAI模組框架 與函式庫 | 資安模組框架 與函式庫 |

Next-Generation DHP Architecture

Medical Applications

HIS	NIS	PACS	SMART APP	CDSS	Health Management Platform	Telemedicine Services
3D Medical Imaging Module	Appointment and Registration	Cross-Hospital Data Exchange	Virtual NHI Card	Healthcare Certification IC Card	Mobile Signature	HRP Healthcare Resource Planning

- Procurement and Inventory (Medical Supplies and Materials) Management
- Human Resource Management •••
- Financial Management
- Pricing Module

System Apps (Common Modules Related to Healthcare)

EMR/EHR Electronic Medical Record	FHIR Service	DHP App Studio	CDS Hooks Express	NHI Claims Submission	Referral	Data Visualization	Healthcare Management Bridge	Physician Support Reporting	•••

API framework

EMR API	FHIR API	SMART on FHIR API	CDS Hooks Discovery & CRUD	Sandbox	Rule Engine	Information Security Audit API	AI/GAI Development API	Zero-Trust Identity Authentication API	Healthcare Management API	•••

SDK

Security Proactive Defense System Information and Audit Trail Aggregation API	AI/GAI LLM/Data Analysis/ Image Analysis SDK
Zero Trust Identity Authentication SDK	UIUX SDK / Sandbox SDK

Docker / Kubernetes（K8s）

- Patient
- Nurse
- Ward, Beds
- Material
- ...

Software Service Modules and Frameworks	Data Storage
AI/Gen AI Module Framework and Libraries	Security Module Framework and Libraries

Community Health Station —— **Provide single system, based on OpenEMR**

Health Center Services from Birth to Death

- Maternal and Child Health Services
- Reproductive Health Care
- Breastfeeding Support
- Immunization
- Newborn Screening
- Enterovirus Reporting

- Smoking Cessation, Substance Abuse Prevention, and HIV Prevention
- Adolescent Sexual Health Education
- School Influenza

- Adult Health Checkup
- Infectious Disease Reporting
- TB, DF and HIV Prevention
- Medication Safety Awareness

- Chronic Disease Case Management
- Cancer Screening
- Vaccination
- ...

- Long-Term Care Services
- Home Healthcare
- Senior Driver Health Assessment
- Elderly Depression Screening

Outdated EHR system for community health centers

- **Decades-old Systems:** Limited upgrades, leading to inefficiency

- **Fragmented Vendors:** Lack of data transfer across systems (vertical & horizontal)

- **Manual Public Health Reporting:** Time-consuming and prone to errors

- **No Integration with Telemedicine or GenAI:** Limits modern care options and insights

THANK YOU!

Welcome
to
Taiwan

Eat, drink and be merry!
Taiwan in-depth travel