

Appendix 1. EHR Planning and Implementation Guideline of the Partnership Model

A. Pre-Implementation

Ref. #	Component	Principles and goals
1.1	Readiness Assessments	To assess the adopting practice's readiness for EHR uptake through a <i>strengths, opportunities, weaknesses, and threats</i> analysis (SWOT). ¹
1.2	Technical Infrastructure Preparation	To inspect existing hardware infrastructure (e.g., workstation performance and network connectivity) to identify areas for improvement.
1.3	Culture Preparation and Change Management	Through interviewing practice leadership and clinician champions ("super users"), culture preparation helps collect user concerns, foster an atmosphere of user participation and ownership, and disseminate project related information to all prospective users via these central nodes in the adopting practice's social network. ² Change management assessments and recommendations are also incorporated in this process based on Lippitt's Model of managing complex changes as five key assets: <i>vision, skills, incentive, resources, and action plans</i> . ³
1.4	Workflow Redesign	The partnership assists participating practices in redesigning their workflow to be compatible with EHR adoption as well as to take advantage of the reengineering opportunities that it offers. The process is generally performed by local CQI teams and supported by the partnership. This process usually takes multiple iterations because not all workflow incompatibilities may be immediately apparent. Further, Change Management principles should be incorporated in all three phases of EHR implementation: <i>pre, during, and post</i> .
1.5	Guided Data Preloading	Preloading existing data stored on paper-based media is an important yet often neglected procedure critical to the smooth transition from a paper-based operation to EHR. It also helps establish a baseline to demonstrate tangible financial and quality gains to reassure the practice's long-term commitment to participation. A research-based guidance provided by the partnership helps adopting practices selectively preload most needed data elements, considering tremendous resources that this process demands.
1.6	Software Tailoring	Primary care practices' needs for EHR functionalities may vary considerably depending on the populations they serve and the service areas they cover. Customizing EHR software to meet such needs is not a trivial task, and can have a detrimental effect on adoption and effectiveness of it is not done right. Through working with many participating practices that have same or similar tailoring requirements, the partnership has a unique advantage, by leveraging

		the network effect, to minimize redundant efforts and assure the quality of the customized functionalities developed.
1.7	Integrated and Upgraded Billing	Misaligned financial incentive is the foremost barrier to EHR adoption in resource limited settings. ⁴ The Partnership Model helps adopting practices integrate and upgrade exiting billing procedures to both accommodate for and take full advantage of introduction of EHR.
1.8	Data Exchange Capability	Ideally, data interfaces with ancillary services (e.g., laboratories and pharmacies) should be fully established before EHR is primed for daily usage, or, temporary solutions need to be resorted to and a concrete timeline of implementation should be developed and adequately communicated to the adopting practice as well as all end users who will be affected.
1.9	Assistance in Negotiation and Working with External Partners	The partnership assists participating practices in negotiation and working with other involved parties, such as vendors of current practice management software, funders, and consortiums of outpatient laboratories and pharmacies. The partnership also serves as a surrogate of participating practices to resolve technical difficulties in establishing and maintaining data interfaces with external parties.

B. During-Implementation

Ref #	Component	Principles and goals
2.1	Shared Hosting	The application service provider (ASP) model is deemed most appropriate for resource limited settings which helps avoid the costs and complexity of maintaining EHR hardware and software locally and individually. The participating practices remotely connect to the centrally hosted EHR server software via secured internet connection. This architecture also allows easy compilation of comparative data so that participating practices can benchmark their adoption progress and performance with peers.
2.2	Training and Retraining	Initial user training is usually insufficient as many adoption issues do not surface until the EHR system has been exposed to a variety of realistic conditions (e.g., time pressure and workplace distractions). Follow-up targeted training is hence essential, and also provides an opportunity for the technical team to discover potential implementation issues directly from end users.
2.3	Formative Evaluation	Formative evaluation throughout the project is essential, so that end users' voice will be heard and issues requiring immediate attention can be promptly addressed. In the Partnership Model, this is achieved by (1) conducting follow-up interviews with key stakeholders, (2)

		examining quarterly usage measures reflecting both general adoption status and the usage of the EHR's value-augmenting modules (e.g., computerized decision-support), and (3) administering clinician EHR evaluation [†] and patient satisfaction [‡] survey questionnaires.
2.4	Performance Feedback	Individually tailored EHR adoption and clinical performance reports are disseminated to all end users that convey encouragement by demonstrating tangible performance gains as well as reminders suggesting margins for improvement.
2.5	Corrective Actions	Based on formative evaluation results, the partnership provides continuous support to participating practices to implement corrective actions as needed. Such actions may include software modifications, network connectivity diagnosis and upgrades, targeted user training, as well as organizational interventions to address unexpected end user resistance issues due to non-technical reasons.

[†] Assessed through an *EHR End User Evaluation Questionnaire* (Appendix 2), developed by the partnership based on the unified theory of acceptance and use of technology (UTAUT);⁴ [‡] Based on the Michigan Academic Consortium Patient-Satisfaction Questionnaire (MAC-PSQ).⁵

C. Post-Implementation

Ref #	Component	Principles and goals
3.1	Leadership Teleconference	Bimonthly teleconferences are held among the leadership of all participating practices providing a venue for timely exchange of information, including implementation experiences and sharing of best practices.
3.2	Annual Partnership Symposium	A symposium of all participating practices has been held annually since the project's onset, which provides an opportunity for key stakeholders to meet in person to share successful strategies, lessons learned, and collectively derive best EHR adoption practices that are particularly helpful for new intuitional members.
3.3	Data Integrity	To ensure that the data being analyzed for quality and research purposes is accurate, consistent, and complete, the Partnership Model incorporates an ongoing strategy for identifying and addressing threats to integrity. Each participating practice is further encouraged to work closely with the Partnership to periodically perform internal checks of data integrity.
3.4	Centralized Analytical Data	The Partnership Model places a prominent emphasis on encouraging participating practices to collect and contribute high quality, standardized patient data to a centrally hosted analytical data

	Warehouse	warehouse in order to derive comparative performance measures and to support clinical and health service research. The data warehouse securely stores multidimensional, de-identified, individual-level patient data and provides functionalities such as federated access to multiple data sources and automated analysis and reporting, based on national standards of quality indicators.
3.5	Research Capacity Building	The Partnership Model is committed to helping participating practices establish vision and infrastructure for contributing to research in the form of supplying data for secondary-use purposes, providing an outreach environment for recruiting prospective patients for clinical trials, and testing new applications such as patient portals.

D. Supporting tools and theoretical frameworks

Component	Tools and theoretical frameworks
Readiness Assessments	Analysis of strengths, weaknesses, opportunities, and threats (SWOT) ⁶
	A computer literacy survey based on Cork et al., 1999 assessing clinicians' use of, knowledge about, and attitudes toward computers ⁷
	An <i>EHR End User Evaluation Questionnaire</i> based on the unified theory of acceptance and use of technology (UTAUT) ⁴
Culture Preparation and Change Management	Semi-structured interviews with practice leadership and clinician champions ("super users") based on a self-developed interview protocol
	The Physician Practice Patient Safety Assessment (PPPSA) questionnaire, usually conducted in a group setting, to provoke thoughts among staff regarding potential patient safety hazards in the current environment and potential gains if EHR is in place ⁸
	The Lippitt Model for managing complex change ³
Formative Evaluation	Repeated measurements of the computer literacy survey, PPPSA, and the <i>EHR End User Evaluation Questionnaire</i>
	Follow-up semi-structured interviews with practice leadership and clinician champions
	The Michigan Academic Consortium Patient-Satisfaction Questionnaire (MAC-PSQ) ⁵
Performance Feedback	Self-developed quarterly dashboard reports on key EHR usage measures and clinical performance measures

References

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