Implementing an Electronic Health Record system at a private hospital in Nepal

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Abstract

Purpose: The purpose of this article is to review a two year long implementation of an electronic health record (EHR) system at the outpatient department of a private hospital in Kathmandu, possibly a first implementation of its kind in Nepal.

Procedures: The strategy designed for EHR implementation was based on Professor John P. Kotter's work on successful change management.

Main findings: We found that keeping a close watch on the social dynamics affecting adoption decisions among users of the system was crucial for implementing the EHR; this was partly because the project received limited support from an erratically changing hospital leadership and lacked an EHR system suited to the needs of the users.

Conclusions: The implementation described in this article is a good lesson on moving from control to drift in information systems implementation, and we hope this work will be useful to health IT professionals working in the space of digital transformation in resource-constrained environments.

Introduction

An electronic health record (EHR) is an electronic version of an individual's health/medical record. Ideally, an EHR is a comprehensive record that includes data on all aspects of a patient's care within a healthcare system, such as: laboratory data; reports from procedures, operations, diagnostic tests, hospital discharges, office visits with healthcare providers, et cetera [12]. While minimizing errors caused due to illegible hand written notes and lost/incomplete health records is one of the many benefits of the EHR, building a future where every person has electronic access to his/her health records anywhere on earth, potentially resulting in improved health outcomes on a scale not seen before may be the holy grail for EHR systems. In addition, the Artificial Intelligence (AI) race that is currently under way may create a reality where, through the combined power of the EHR and AI, curing human suffering caused by diseases might look rather different in the next generation and healthcare delivery as we know it today may not exist in the near future.

Despite the potential of the EHR to *revolutionize* healthcare, data on implementation and adoption of EHR systems in Nepal is scarce. All academic work so far has focused on greenfield implementation of EHR systems in public healthcare institutions in rural Nepal [11], [14]. By contrast, healthcare specialists in the country prefer working at private institutions in urban settings or migrating to 'developed countries.' Health workers with the least experience generally choose air-linked, remote parts of the country [10]. Furthermore, no work so far has paid attention to healthcare institutions that may be stuck in their digitization efforts for various reasons. In this paper, we offer a different perspective to what has appeared in the literature so far by describing the experience of recovering a troubled project that aimed at implementing an EHR system at the outpatient department (OPD) of a private multispecialty hospital in Kathmandu, the capital city of Nepal. We walk the reader through a change management strategy that was designed for project recovery, the obstacles faced while putting such a strategy into force, the solutions and workarounds devised to tackle those obstacles, the mistakes made, and the wealth of lessons learned in the process.

Project background

The EHR implementation project began sometime in early 2014 at the outpatient department of a 150 bed hospital. The OPD had an average monthly footfall of over 9,000 patients in 2014; this number was subject to seasonal variations and grew to over 11,000 in subsequent years. The EHR project was initiated by the then Chief Operating Officer (COO) of the hospital with approval of the hospital's chairman. The hospital had seen a surge in digital initiatives since the arrival of the COO in 2010, with services such as laboratory, nursing, intensive care units and the inpatient department digitized during his tenure. A year after the COO was prematurely removed from the digitization program and placed in a different organizational unit, we were hired to complete his OPD digitization efforts under the supervision of a different COO. This paper is written from the perspective of a technical consultant who was hired from outside of the hospital and was solely responsible for implementing the outpatient EHR system.

During the first 21 months of the project, monthly output of EHR had peaked at 12% (1,291 out of 10,693) of total outpatient registrations in July, 2014. Output then steadily declined in the following months, with a 3% (308

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out of 10,219) output in September, 2015 (the month of handover). Project progress in the first 21 months is shown in figure 1. The reader may notice that the steady decline in project output following a brief surge early in its life cycle contrasts with projects normally running into trouble toward the end of their life cycles [13]. One reason for this anomaly could be because the hospital lacked a project management office to monitor and control projects. During the 21 months of our full-time involvement—starting in September, 2015—the project saw a 20 fold increase in monthly output and five project heads, of which four were hired from outside of the hospital (and country).
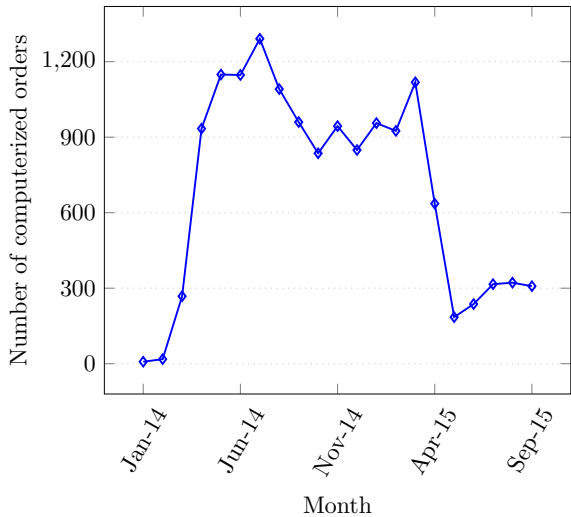

Figure 1: A chart showing EHR output as the number of orders generated electronically for a given month.

Application overview

The EHR application was available as a module within the hospital's information management system; the system was hosted on premises. A provider could access the application through the Google Chrome web browser on a desktop computer available at the provider's desk. Access control was maintained through single factor authentication, and an average user did not change her/his default password, which was the same for all users!

On selecting the EHR module after authentication, the page that opened next displayed a list of patients assigned to a provider on the current day, with options to search for patients whose names were not displayed by default. On clicking on the patient ID (an alphanumeric link) of a patient, a new page would open; this page was the patient's electronic health record. For purposes of this section, the patient will be named Avia and her provider will be named Brock. Avia's EHR consisted of the following:

- Patient metadata,
- Provider orders,
- Laboratory test reports,
- Additional attachments,
- Data on hospital admissions.

For purposes of this paper, we only focus on the *provider orders* component of the EHR since the other elements of Avia's EHR were sourced from hospital departments that

had already been digitized. The provider orders page displayed a table of previous orders for Avia. The table consisted of, among others, Avia's medical diagnosis and prescriptions so that each subsequent provider working with Avia's EHR would get a snapshot of her medical history. A provider would then have the options to:

1. Enter a new record for Avia,
2. Edit a previous record if the previous record was created by the same provider,
3. Print out Avia's order for review, or for handing the printed order to Avia/an authorized individual.

If Brock chose to enter a new record or edit a previous record for Avia, a new tab would open in Google Chrome; the new tab/window consisted of the following.

1. Patient metadata.
2. Multiple tabs within the window where Brock could enter Avia's:
   - Vital signs,
   - Medical history,
   - Physical examination observations,
   - Drug history, family history, social history, investigation history, allergy information,
   - (Electronic) prescriptions and orders for further investigations, procedures, and vaccines.
3. Text boxes for entering Avia's diagnosis, provisional diagnosis, advice for follow up, etc.
4. A link for prescription refills.
5. Push buttons to save, print and exit.
6. Drop-down lists and links for creating, reading, updating, and deleting templates/order sets.
7. A check box and drop-down list to select from a somewhat curated list of physicians for referrals.

Methods

In this section, we describe the strategy that was designed for recovery of the EHR implementation project. Our strategy has been influenced by Professor John P. Kotter's book on leadership and change [9]; in their book—written as a fable—Kotter and his co-author tell the story of how a penguin colony decides to move out of a melting iceberg that the penguins called home and how the colony discovers a new way of nomadic living during the transition. Kotter's teachings on change can be distilled into the following statements: People are less likely to change themselves and others based on data and analysis than on compelling experiences; feelings often trump thinking, and change is emotional [9]. We organize this section into the following subsections, each capturing one or more of the eight steps for successful change management described in Kotter's seminal work [8], on which [9] is based.

Setting the stage

A challenge that we were not fully able to tackle during our time at the hospital was creating a suitable environment for smooth EHR implementation. Recognizing that successful implementation would require efforts from many levels of the organization, we began our change management efforts by forming a steering committee for project oversight. The steering committee consisted of:

- The chairman,

- The chief operating officer (COO),

- An attending physician (endocrinologist),

- The technical consultant.

Our choice of staff for the steering committee turned out to be poor, partly because of our limited understanding of organizational politics. During the eight months of its existence, the steering committee met for a total of one time, made no significant project related breakthroughs, and quietly dissolved after the sacking of the COO.

Further, the chairman's ineffective leadership made it even harder to create a favorable environment for project execution. One of the few times the chairman communicated with medical stakeholders was when his office sent a generic email to a select number of physicians who had refused to participate in EHR training. In his email, the chairman talked about his dream to make his hospital 'paperless,' exaggerated that the project had reached a significant level, and personally requested each physician to spare some time for training. However, the chairman made no mention of how his paperless ambitions would benefit patients and providers, and made no effort to invite feedback on the project; this occurred despite our efforts to *educate* the chairman on the importance of stakeholder engagement.

A possible explanation for the difficulty in creating a suitable environment for the project may be the lack of a competing institution in the country that was making remarkable progress with EHR. Since Health IT adoption decisions are likely to be influenced by the actions of peer institutions, as written in [1], the lack of such a peer institution may have resulted in EHR implementation not falling into the organization's priorities. Besides, hospital leadership was well aware that successful EHR implementation would not directly generate income for the hospital, which for a for-profit hospital seemed like the most important criterion for determining project priority.

Deciding what to do

We began work on the EHR at a time when the chairman wanted full implementation (spearheaded by the COO) by December, 2015. During our time at the hospital, implementation deadline shifted more than once, with the last deadline set as: 'by 2017.' The full implementation requirement seemed to be set at whim by the chairman, without taking into consideration a phased implementation approach that would have suited the hospital better. The chairman's unrealistic expectations and rapid changes in project heads made it unnecessarily stressful to plan and execute the project sensibly. We eventually decided that the project would move in phases with high profile and high output providers targeted first.

A phased implementation seemed to be the most appropriate for a hospital in a 'developing country' as discussed in [5]. Our choice of high profile/output providers was to try to benefit as many people as fast as possible; a provider who is the one of the best in the country and can bring around a thousand patients into his/her office for consultation every month seemed like a better person to start with than a provider that can barely bring fifty patients in a month. Our phased implementation approach contrasted with the chairman's full implementation requirement, and targeting a small group of high performing providers did not help advance the chairman's narrow organizational objectives that would be achieved if every provider typed orders into computers; we will not comment further on those narrow organizational objectives.

Making it happen

We describe this aspect of our change management strategy through the following headings.

User training

During the initial phase of project recovery, we came across a sobering fact that at the time of project handover, only 24 (out of 72) attending physicians had been trained to use the EHR. Many providers were not only untrained but also unaware that the hospital had an EHR system that they could use if they chose to. Before we took on what would turn out to be a non-trivial undertaking of scheduling and delivering training to around 50 providers one after another, we saw fit to first meet as many *trained* providers as possible to take a 'pulse' of those using the EHR. We met and shadowed providers for up to an hour as they used the system and generated orders for patients. At the end of the meeting, we asked a cooperating provider to fill a brief questionnaire in order to get a rough measure on system usability; we will not comment further on our usability testing efforts.

The first training for a provider was conducted at his/her office with, excluding some exceptions, no patients present in the room. Subsequent training sessions, if provided, were usually with patients present. Trainings were delivered as software walk-throughs; we sat each user in front of a computer and asked her/him to click and type on elements on the screen as we sequentially demonstrated the various features of the EHR system. Before the start of most training sessions, we showed sample orders prepared by other users and we ended most training sessions by handing printouts with some essential information.

Some of the challenges faced, mistakes made and lessons learned during user training were the following.

- Setting up and testing equipment needed for train-

ing turned out to be quite the logistical challenge due to issues with procurement (reluctance of authorities to approve purchase of computers, inefficient procurement department and processes), issues with quality of the equipment received, lack of appropriate space to house the equipment, and inconsistent quality of work of support personnel responsible for setting up and testing equipment installed at various locations.

- Once required equipment was set up and operational, scheduling training sessions with providers turned out to be another logistical challenge due to some of the providers' unwillingness to give time for training. A number of providers who were willing to give some time missed multiple scheduled training sessions for a variety of reasons, resulting in a lot of time wasted in waiting and rescheduling.

- Training sessions did not begin with an overview of learning outcomes for the trainee and did not end with a short quiz that tested those outcomes. This was a weakness of our training design.

- We had blurred out patient identifying information on sample orders that were shown at the start of a training. However, we did not conceal provider information in the sample orders and did not ask for permission before using such orders as samples. All of this was a blunder that should have never occurred.

User engagement

We paired user training with a user engagement phase aimed at a select number of providers once we realized that simply training providers may be insufficient to change workflows from paper to computer. We describe our user engagement efforts through two *waves* that were aimed at catapulting monthly output of computerized orders.

The First Wave

We targeted a renowned pulmonologist and his team of residents and interns for the first wave of our user engagement efforts. The pulmonologist will be referred to as 'the attending' and we will name his team members: Ana, Raj, Kai, and Lok; all names in this paper have been changed. We initially shadowed Ana for a month or so. Ana was the only intern in the team and thus had to bear the burden of changing her workflow first; the team's first set of templates (order sets) were made as per Ana's instructions. Though the project did not gain much traction through Ana—who eventually left the hospital in the following months—the time spent shadowing her was sufficient to build working relationships with the residents, especially Raj and Kai.

The attending's residents had mixed initial reactions to the EHR. While Raj and Kai could see the point behind the initiative, they could not see how EHR would be feasible for a team that could see over 50 patients on a given day. In addition the residents were not good typists, and since the templates prepared by Ana were not always to their liking, the time investment needed on Raj and Kai's part for EHR implementation was non-trivial. So during the initial months of tumult, we

assumed the role of a 'coach' in order to keep the two motivated in routinizing their new workflows, as suggested in [1].

In the many months of shadowing the residents, we made an interesting observation that there was competition between the two residents that was somewhat disguised by an enforced camaraderie in the team. This meant that if one of Raj or Kai moved significantly ahead of the other, the other resident would inevitably catch up; thus a way to speed up EHR adoption was to leverage this by closely monitoring both Raj and Kai's output and facilitating one of the two residents to race ahead. We exploited this new-found knowledge by taking turns to motivate either Raj or Kai to race ahead.

The main reason for shadowing the residents relentlessly during the first several months of implementation was because the attending's outpatient workflow was heavily reliant on the residents, as illustrated in appendix A. Furthermore, gaining each resident's confidence was crucial to gaining the attending's trust in the system, which was rather low at the beginning of implementation. After many months of working closely with Raj and Kai, we noticed that as the two residents became increasingly comfortable with the new way of working, the remaining resident in the team (Lok) transitioned from paper to computer gradually but rather effortlessly, with minimal work required on our part. So with all residents on board, EHR finally became a reality in a team that was once thought of as *impossible* by many in the hospital; we refer the reader to figure 2. A percentage next to a diamond in figure 2 denotes the share of computerized orders produced in the corresponding month.
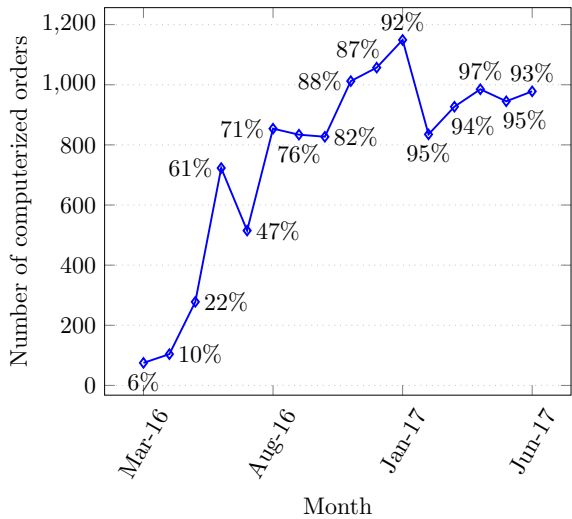

Figure 2: A chart showing monthly EHR output for the pulmonologist and his team.

The Second Wave

For the second wave of our user engagement efforts, we targeted a high output endocrinologist and a highly influential cardiologist at the hospital. The endocrinologist's team consisted of a nurse who mostly helped prepare prescriptions for patients, and the cardiologist's team consisted of up to six nurses and three cardiology residents who had varying responsibilities.

We began our work with the endocrinologist's nurse, Ara, by preparing a set of templates consisting of a couple hundred permutations of commonly prescribed diabetes and thyroid medications. Once the templates were ready and Ara was somewhat comfortable with using the computer, we started shadowing her on a regular basis. We present Ara's workflow in figure 3; the activity diagram shows the part of a patient's journey after the endocrinologist has examined the patient and scribbled a handwritten note. The reader should immediately notice that the workflow diagram is remarkably simple when compared with the diagram presented in appendix A. This is because we had initially asked the unwilling endocrinologist to consider at least providing electronic prescriptions to her patients so that prescription related errors could be minimized. While we barely succeeded in gaining support for electronic prescribing, we could not negotiate further despite many months of trying, resulting in Ara producing e-prescriptions and nothing more. We present her progress with e-prescribing in figure 4.
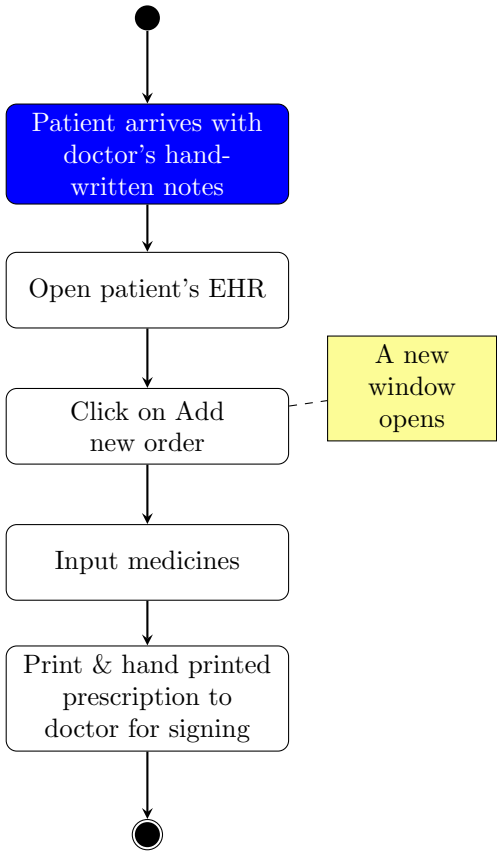

Figure 4: A chart showing monthly e-prescription output for Ara.

Figure 3: A UML activity diagram showing Ara's workflow; a rounded corner rectangle with white fill shows a task to be carried out by her.

Working with Ara was quite easy and pleasant, however working around the endocrinologist's mood swings was not always pleasant. The monthly fluctuations in figure 4 can be partly attributed to such mood swings, following which the endocrinologist would arbitrarily prohibit/discourage Ara from e-prescribing. After such mood swings, we sometimes had to talk Ara out of not preparing e-prescriptions, otherwise she was very consistent with her work. Since the endocrinologist showed no interest to move from e-prescribing to a comprehensive EHR for her patients, moving on to another team of providers seemed like a better use of our time.
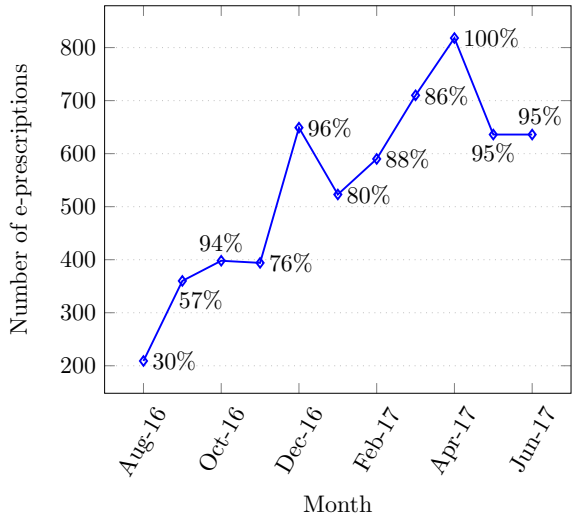
Our work with the highly influential cardiologist began with his team of nurses; the cardiologist will be referred to as 'the attending.' The attending's first few months of progress with the EHR can be largely attributed to the nurses, in particular one nurse—call her Ihna. Ihna, along with almost all of the other nurses in her group, was very competent at using the computer and web applications. However, none of the nurses had much order writing authority and simply typed whatever was dictated by the attending, who did not care much about the EHR. While there was not much need to shadow the nurses, we nonetheless shadowed them regularly until the attending finally asked us to involve his residents with the EHR.

The first cardiology resident that we trained and shadowed will be named Tony. Although Tony showed some initial interest in the EHR, after a week of shadowing him, we felt like our time could be better spent elsewhere. While shadowing a pulmonologist's team in the first wave of user engagement, we had noted that exploiting the competitive spirit between the residents in the team made a noticeable difference in project performance. We hypothesized that a similar spirit existed in this team of cardiologists as well, and put the hypothesis to test by engaging with the next approachable resident in the team.

The second cardiology resident that we trained and shadowed will be named Akes. Akes was rather different than the providers we had supported thus far because he showed little interest in making templates on his own. Akes neither prepared templates on his own (like the pulmonology residents did), nor did he compile his requirements on paper for us to type into the computer (like the endocrinologist's nurse, Ara did). This left us in a sticky situation where we needed to perform a text analysis of all EHR entries made by the attending's team, search for patterns in the text, understand some of their jargons, prepare templates that we thought would be useful, have Akes check if the sets were to his liking, and repeat as required. After much toil, we prepared a number of templates for commonly used medications, diagnostic tests, diagnoses, et cetera. To our great relief, Akes started using the EHR considerably less reluctantly once we entered a sufficient number of

templates into the system. We still had to shadow Akes regularly, partly because of his limited computer skills, however he threw no more surprises at us.

After almost three months of working with Akes, we noticed that Tony (the first resident) had started using the EHR without our support, as hypothesized when we started working with Akes. Around the same time, the third resident in the team left, reducing team size to 1 attending, 2 residents and 6 nurses. Since the 2 residents (Akes and Tony) were using the EHR quite well by now, and had sufficient order writing authority, we saw a hike in the team's output as seen in figure 5.
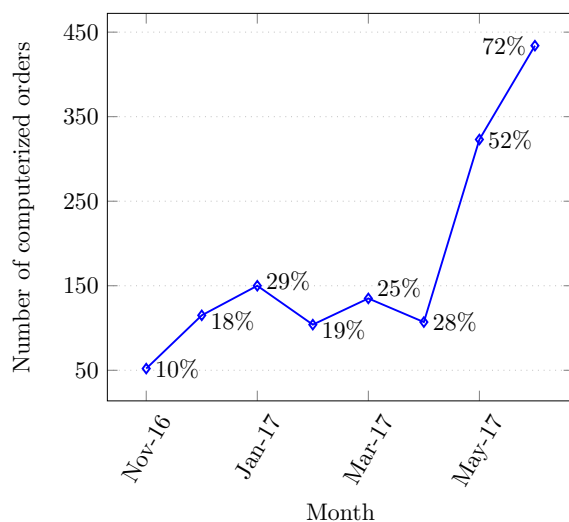

Figure 5: A chart showing monthly EHR output for the cardiologist and his team.

The only weak link in the team turned out to be the attending who, despite both his residents being on board, still showed low interest in fully transitioning to the EHR. We assume such a lack of interest could be due to his highly influential status at the hospital (and country) that made him feel like his old way of working was the *right way*, or it could also be because he thought medical record keeping was a mundane and inconsequential task, as hinted in [12]. Whatever the reason, we did not find it appropriate to try to coerce the attending (indirectly through hospital leadership) into using the EHR. So we left the attending alone in hopes that some day he would support the new way of working.

Application management

Our view of application life cycle management includes three areas: development, operations and governance [3]. The EHR application was supplied to the hospital by a foreign vendor that controlled the development aspect of the application life cycle; we were responsible for the operations aspect of the life cycle, and the hospital lacked the means to provide suitable application governance.

One of our main responsibilities was to maintain a feedback loop so that requirements could easily move from end users to the software vendor. We received, recorded and analyzed user requirements, and submitted requests for change through the vendor's project tracking system. Before we could move to requirements gathering and reporting however, we had to overcome a power struggle within the IT department in order to obtain access to the project tracking application. There were no set standards for reporting change requests to the vendor, so most requests were free-form, along with a few examples that elaborated on the desired outcome.

We inherited processes that deployed software updates from the vendor directly into the hospital's production environment. This created unnecessary stress whenever problems with new software releases blew up in production. After a few mishaps, we determined that system testing was essential in order to maintain software reliability for end users. We spent over a year working on the various details needed to introduce system testing into the hospital's IT processes, however despite repeated attempts, we were not able to convince hospital leadership to fund the system testing initiative. In the absence of testing, we had to resort to ad hoc smoke tests while releasing new versions of the software, hoping for the best. We subsequently decided to release updates into a 'parallel' production environment accessible to select users and gradually transitioned the main production environment to match the parallel environment.

IT service management

IT service management was a rather tricky problem since the hospital lacked a system for handling incidents, service requests, problems and changes. This led us to ad hoc ways of recording and tracking user needs and requests, and made it difficult to define and analyze metrics for the various services provided by the IT department. Configuration drifts were also rampant, and a lot of time was lost to rework and putting out needless fires. While these issues could have been solved through internal IT re-engineering, the hospital faced a dilemma of whether re-engineering a 'small' back office was a financially prudent move; such dilemmas are not uncommon in organizations with traditional IT shops, as discussed in [4].

Monitoring and controlling

Our approach to monitoring and controlling the project was both analytical and people-oriented. We closely monitored EHR output on a daily, weekly, monthly and ad hoc (often times, hourly) basis. In addition, we spent a lot of time on the hospital floor interacting with both medical and non-medical staff to see whether the reports were congruent with what was happening on the floor.

Most of our project monitoring reports were spreadsheets that tracked EHR output with respect to providers at regular intervals. These reports were not only useful to see how the project was progressing overall, but also to see how each individual user was progressing. We also produced reports that detailed how each user was utilizing the various features of the EHR application; such reports were useful to see how well a user understood the application and where the user stood in her/his transition from paper to computer.

We show one of our project monitoring reports in figure 6; the chart shows EHR output from the start of the project until our departure. The dotted vertical lines in figure 6 denote a change of supervisors. The reader will notice that project output showed the highest jump during the time of our fourth supervisor. This was no

coincidence. By the time the fourth supervisor (a General Manager/GM) came to lead the project, we had spent a year in the hospital and had a reasonable understanding of the context in which the project was operating. Moreover, the supervisor was appointed from within the hospital and was a consummate insider who had spent a decade in the hospital working from the ground up. This turned out to be a great asset for the project because the GM could pick the low hanging fruits considerably easily; that is, while we were concentrating on engaging with the high output and high profile providers (see section *User engagement*), the GM successfully convinced a number of low output providers to use the EHR. This was a rather *easy* task for the GM since he knew most of the providers personally due to his long association with the hospital.

However, our time with the GM was cut short arbitrarily by hospital leadership, and we had a final change of supervisors in May, 2017. The hospital replaced the GM with an outsider with no experience in/understanding of digital transformation. A month later, we cut our association with the project and subsequently left the hospital.
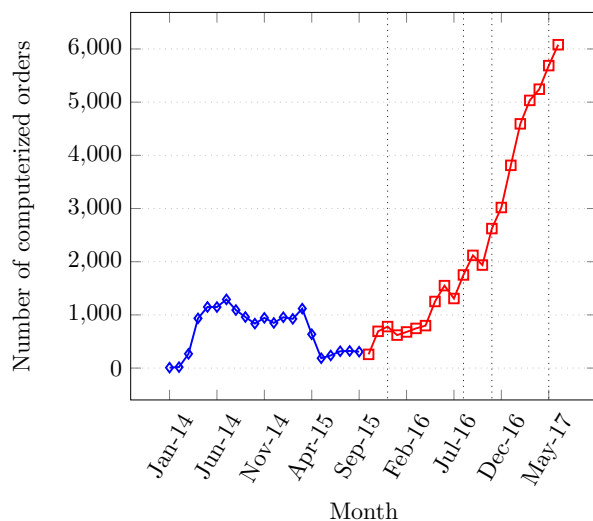

Figure 6: A chart showing monthly EHR output; the blue line shows output before our involvement and the red line shows output during our involvement.

Results

We use this section to elaborate on the lessons learned through the project. We organize the lessons learned into seven categories as defined in [6]; each paragraph that follows addresses one or more of those categories.

Functionality: An unfortunate consequence of procuring an EHR system from a foreign vendor with no awareness of local contexts was the workarounds required in order to run the system as intended. Since the software was procured before any workflow analysis, the entire implementation had to be geared toward somehow mapping user workflows to the system, instead of first understanding workflows and then asking the vendor for a bespoke solution. Furthermore, since the vendor did not release an API for the system, we were not able to add functionalities on our own in order to make the user's (and our) life easier.

Organizational: Changing attitudes toward the EHR was the most significant organizational challenge that we tackled. Due to limited commitment to EHR implementation by hospital leadership, the onus of communicating with stakeholders to stimulate use of the system fell on our shoulders. This was a tricky job not only because of our initial 'outsider' status in the hospital, but also because no two providers were the same in the way they worked and communicated. In addition to understanding various user workflows, we also needed to keep an eye out for the social dynamics affecting adoption decisions among users (see section *User engagement*).

Technical: There never was a shortage of technical problems facing the project. We have elaborated on some of the problems, such as the lack of system testing and a general lack of procedures on IT service delivery, in sections *Application management* and *IT service management*. In our view, technical problems were merely symptoms of a larger issue; the IT department at the hospital was one of the newest units that had started as a scarcely resourced electronic data processing unit. Even though times had changed and the IT unit was set to become a key player in the hospital's future, leadership still seemed to view IT folks as—in the words of [7]—glorified janitors. This viewpoint was the most significant 'technical' issue facing the hospital.

Training & Political: We have elaborated on the lessons learned from training—mostly related to training design and delivery—in section *User training*. In addition to training, computer literacy was a major hindrance to the project. Many users not only lacked basic computer skills, but also seemed to not trust computer systems. Add to this the hospital's characteristic resistance to change and the nascent health IT industry in the country, we had the perfect mix for a sluggish project with time overruns as a result.

Ethical: We left the hospital with an uneasy feeling of implementing an EHR system that was, in our view, not sustainable. Since our implementation approach was heavily reliant on users agreeing to include the EHR in their workflows, every time a user left the hospital, there was a good chance that the next user would choose not to use the EHR. A user was well within his/her rights to do so because there were no rules mandating the use of outpatient EHR systems at the hospital. Although user turnover was not high for senior doctors, turnover was alarmingly high for junior doctors and nurses. The reader may recall that junior doctors and nurses carried out the bulk of data entry for high output senior doctors.

Financial: A lot of the project's (and life's) problems could have been solved by simply putting the right people in the right places. The hospital could have executed the project much more efficiently had it paid close attention to the division of labor instead of asking a person or two to wear many hats and execute an ambitious project.

Discussion

The reader may have noticed that all of the charts in this paper show numbers and/or percentages of computerized orders output under various situations. There is a conspicuous absence of charts that show how health outcomes may

have improved through use of the EHR system. This was in part because measuring health outcomes was beyond our job description and capability, and in part because the hospital lacked the capability of measuring health outcomes. Thus digital transformation was confined to capturing and storing data.

Further, we spent considerable time elaborating on *user engagement* in this paper. While user engagement is an essential part of any implementation project, it was indispensable in our case. Due to the lack of a reliable EHR system (see section *Application management*) and limited support and guidance from an erratically changing hospital leadership (see sections *Project background* and *Deciding what to do*), our last bet on taking the project anywhere was to negotiate with each provider, convince him/her to use the clunky system, and wait patiently for momentum to build. This was an inefficient way of moving the project forward and made it difficult to plan the project in great detail, because how does one plan on how long it will take to convince someone? But perhaps such unpredictability of health IT implementation is an inherent characteristic of the implementation, and as mentioned in [2]: in such instances, one does not know at the outset where one ends; one does not 'redesign' according to some plan; one rather 'drifts' with the current, attempting to steer one's project through the ever changing environment.
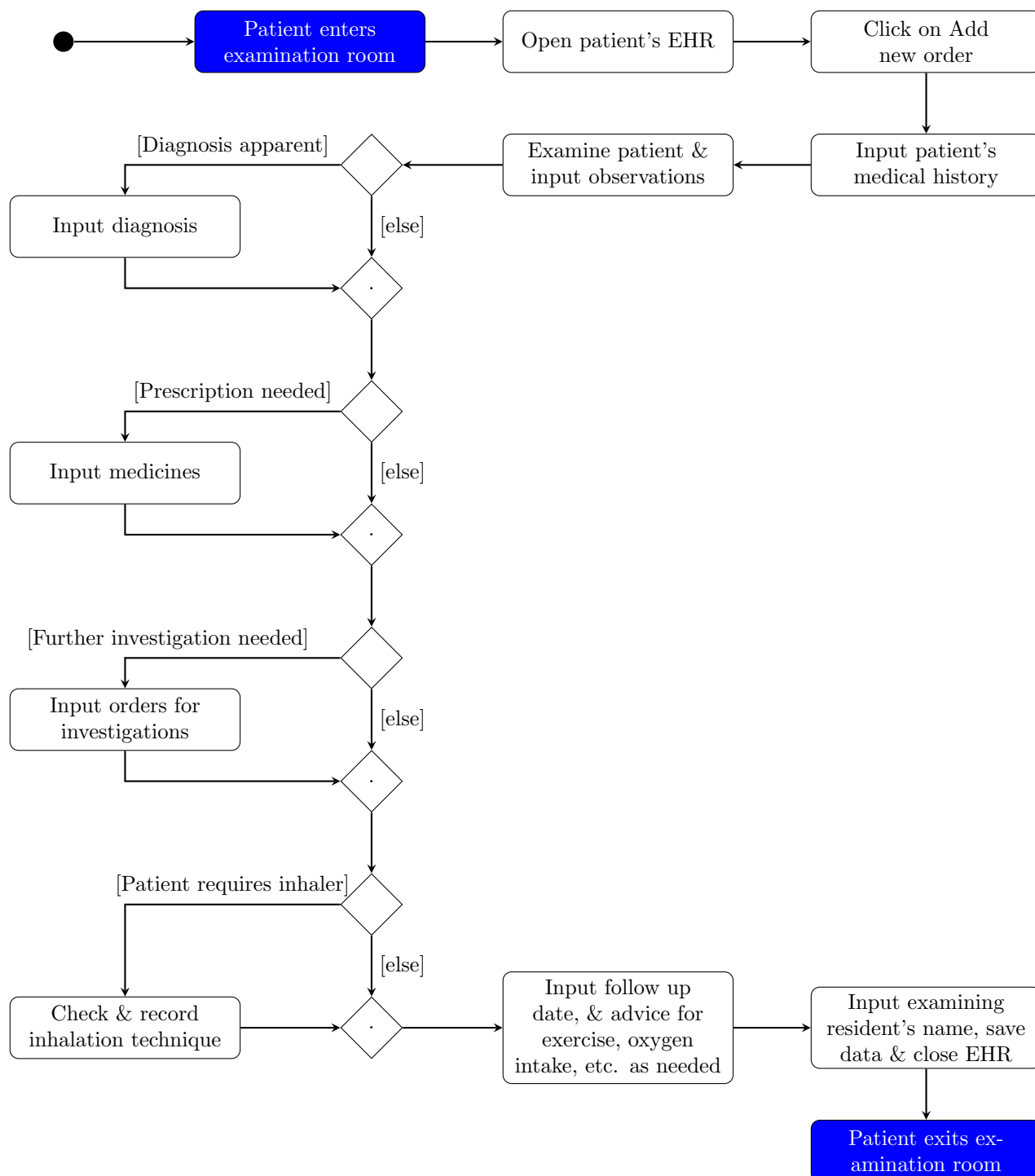
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Appendix A

Here, we present UML activity diagrams that show the workflow of the team of pulmonologists in the first wave of *user engagement*; the team of cardiologists in the second wave had a fairly similar workflow. The following diagram shows a pulmonology resident's workflow, with a task to be carried out shown with a rounded corner rectangle with white fill.

On exiting the resident's room, the patient would proceed to the attending physician's room. We show the attending's workflow next, with a task to be carried out by him shown with a rounded corner rectangle with white fill.