Pilot Study of an Intended Medically Accurate Online Flu/Cold Assessment Tool in a University Health Setting

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Objectives: Reduce burden of care for flu/cold patients, decrease unnecessary clinic visits, and improve access to care utilizing an online assessment tool. **Participants**: During the 120-day pilot, in a clinic serving 3961 graduate students, 144 patients voluntarily used the tool. **Methods**: Students selecting cough, cold, or flu-like symptoms in their online appointment were given the option of using an intended medically accurate assessment tool. The software collected data for diagnosing flu, sore throat, mononucleosis, pneumonia, and cold. While tool gave patients feedback regarding their condition, all patients were contacted by a clinician. **Results**: 144 unique usages, mean interview time 119 seconds, 4.5 out of 5 rating in clinician opinion survey, 49% after-hours usage, 36% of patients were triaged for visits and calls, and 84% of patients submitted their reports. **Conclusion**: Clinicians found the tool helpful, usage continues, and we plan to expand to topics such as STI screening and UTI.

Keywords: Health IT, influenza, online assessment, automatic EHR documentation, patient clinician communication.

Introduction

Upper respiratory infections (URIs) and influenza like illnesses (ILIs) are a common cause of substantial morbidity and occasional mortality among university students. Attack rates are high on college campuses. One study reported 91% of students had at least 1 URI, 83% at least 1 cold, and 36.7% at least 1 ILI during a six month period from November 2002 through April 2003.[1] University health centers, as the primary care clinics for this population, struggle to provide care during the flu season. The ability to triage student with URI, cold and ILI, most of whom are best managed at home, is a major challenge for health centers. Enhanced triaging of these patients could improve the health and well-being of the 20 million college and university students in the US by freeing resources to be focused on the more sick patients, and reduce the chance of disease transfer to patients and providers due to unnecessary clinic visits. During 2018-2019 flu seasons, a west coast university health center (referred to as Clinic site) addressed these problems by using a software tool developed by a commercial vendor in a pilot project.

Previous work. While questionnaires for speeding up a visit are not uncommon, they usually do not contain skip logic (are static), are not comprehensive, and do not contain next steps. Some assessment tools go further,[2] but still appear to have simple logic, do not contain next steps, are cumbersome for patients to use, and are not meant to be integrated into the clinic's workflows. Virtuwell is an example of an online clinic with a questionnaire front-end,[3] but the software appears tied to the clinic, collects protected health information (PHI), and does not give patients feedback. Zipnosis provides a platform where patients go through an adaptive questionnaire,[4] and a clinician sends them a diagnosis and treatment plan hoping to replace telehealth by avoiding in person visits, callbacks or video calls. Their work differs from ours in the following aspects: 1) We called all patients, 2) their software does not provide any feedback to patients automatically, 3) they collect PHI, 4) their tool does not generate EMR notes automatically, and 5) our online tool is meant to be medically accurate while we are not aware that their tool has the same goal. To our knowledge, this is the first application of its kind offering an intended medically accurate online assessment tool for a reasonably

complex topic (5 respiratory infections), integrated tightly within a clinic's operation, interviewing the patient and taking history of present illness and past medical history, suggesting next steps, providing patient feedback, automatically generating electronic health record (EHR) notes, available to patients at home and on their device of choice, fast for patients to use, and not collecting any PHI. Our approach is generalizable to any clinic offering primary care services, with fairly easy integration into the clinic's EHR and workflows.

Methods

Setting, theory behind procedure, and history with procedure

Clinic. The pilot site was a west coast university health center. The health center serves approximately 3,961 medical, dental, nursing, physical therapy and graduate students.[5] Adult dependents of students may also use the clinic. We don't have a way to tally their numbers, but clinicians estimated visits by dependents to be no more than 1-2% of their total annual visits. The clinic is staffed by four physicians, two nurse practitioners (NP), and three registered nurses (RN) during the hours of 8am – 7pm Monday, Wednesday, Thursday and 8-5 on Tuesday and Friday. Same day appointments are reasonably easy to get with the cutoff being 3:30PM. The clinic uses PointNClick™ EHR.

Theory behind procedure. This procedure was chosen as the software appeared capable of:

- Improving *efficiency* by taking patient history, creating clinical notes and providing some case specific patient education;
- Improving *access* by being available in off hours and in convenient home settings;
- *Triaging* by providing acuity for cases;
- Organizing *load management* by having some patient cases ready when clinic opens in the morning;

- *Standardizing care* by suggesting next steps based on guidelines such as those from Centers for Disease Control and Prevention (CDC) and Infectious Disease Society of America.
- Improving *quality of care* because the software follows guidelines and supports a best practice model.

History with the procedure. The clinic began experimenting with the software 12 months prior to the pilot by having patients in the clinic use it in presence of a clinician. Towards the end of the previous flu season (9 months before the pilot), the tool was offered as informational to patients from the clinic's website. Each stage was received positively prompting the pilot, increasing the use of the software.

Procedure

The procedure was implemented by the clinic's IT staff within the patient portal without any involvement from the EHR vendor.

Link from portal. Inside the patient portal's appointments section, patients were first asked about the type of appointment they needed such as primary care, women health, nutrition, etc. If a patient selected primary care, then the next screen had several options including "Cough, cold, or flu-like symptoms." Patients who chose this last option, i.e. self-identified as having symptoms of a URI, were offered a link to the vendor's flu/cold tool. Upon clicking on the link, they were anonymously logged into the vendor's tool. A conditional logic algorithm that emulates a clinician interview was used to interview patients regarding their condition. Based on the results of the questions, the potential next steps were outlined (e.g. lab test, clinician evaluation, anti virals, etc), and patients were asked if they were ready to submit the result. Submitted results, including the randomly generated ID, were sent to the nursing inbox. Patients would then paste this random ID as part of their appointment request, which would tie the report to the patient. A licensed clinician, generally a RN, would contact the patient back within 2 hours during business hours or the next business day otherwise. If a patient needed urgent care, patients were

shown a link provided by the clinic to after hour urgent care options in case the clinic was closed. Figure 1 shows the workflow.

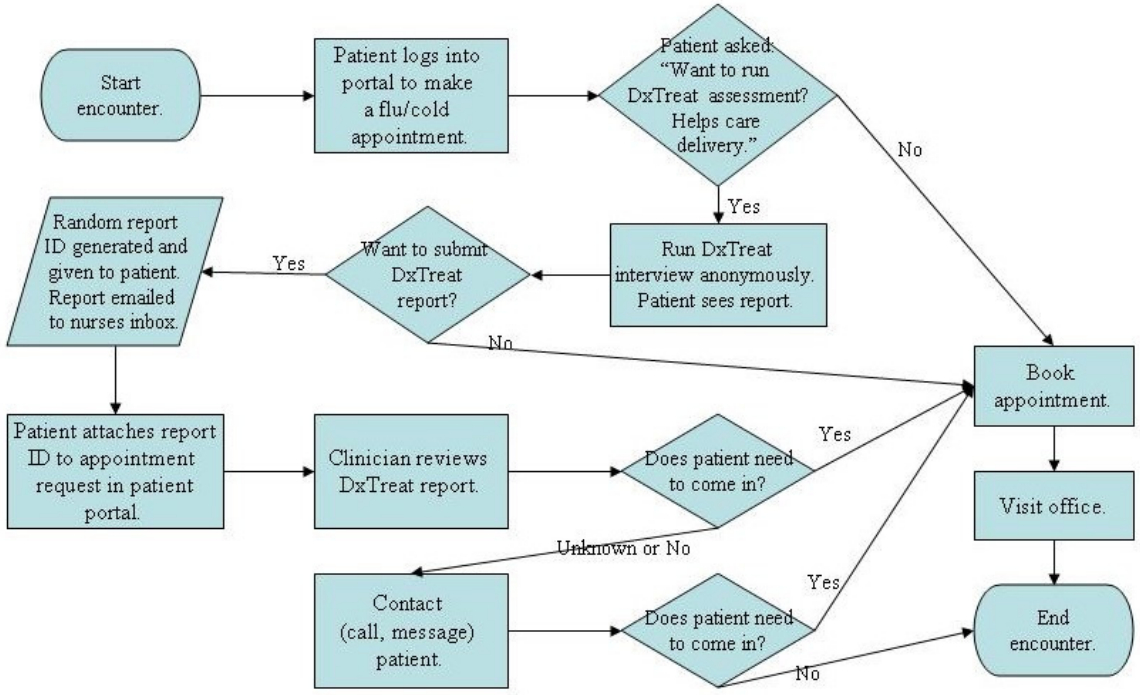

Figure 1. Flu/cold encounter with DxTreat assessment tool.

Vendor's software collected no PHI, but collected personal medical history. We believe for security and privacy reasons it is important that third party tools refrain from collecting PHI (such as name, medical ID and phone number) as much as possible. The vendor's software did not collect any PHI's as the login was anonymous, and we used randomly generated case identifiers, which the patient sent in to the clinic inside the EHR, to connect the patient with the case. Not collecting PHI is especially important in more sensitive topics such as sexually transmitted infections (STI), where encouraging usage while remaining anonymous initially is likely to lead to higher utilization and improved outcomes. The tool still collected relevant personal history such as flu vaccination, chronic diseases, being health care worker and travel to areas with high flu incidence.

Patients were encouraged to send in all reports. Our goal was not to reduce the number of patients who sought help, but rather, to organize and improve the process of receiving

care. Therefore, patients were encouraged to send in all reports, and a clinician would contact each of them back.

Vendor's software flu/cold topic covers 5 diseases. This topic targets 5 diseases: flu, cold, strep throat, pneumonia, and mono. Usage has continued after the flu season, albeit at a slower rate, with patients mostly suffering from cold, mono, and sore throat.

Vendor's software is intended to be medically accurate. Vendor's software next steps are intended to be medically accurate, meaning the tool collects the appropriate information needed for medical decision making subject to restrictions of online usage, and suggests the next steps to diagnose and treat the condition based on how the case is understood at that time. Some symptoms, such as tonsillar exudate, may be unknown at the interview time. The system also flags symptoms of particular concern. These 'red flag' symptoms, such as short of breath at rest or coughing up blood, are highlighted by the software and urgent follow up is suggested. If patient's condition appears to not fall within the topic (e.g. only symptom is nausea), then a "beyond topic" output is produced. Guidelines,[6-8] CDC and NIH publications,[9-15] and research papers provide some of background information used in developing the vendor's software flu/cold tool.[16-19]

Vendor's software is not meant to provide a diagnosis or treatment plan, rather, provide information that a licensed clinician will review to make care plans. The feedback provided to patients is to improve their use experience by making information available to them with the understanding that their care decisions will be made by licensed clinicians.

Since red flags are of particular concern, we enumerate below all conditions which result in an urgent evaluation: shortness of breath at rest, coughing up blood, severe dizziness, and severe sore throat combined with difficulty opening the mouth, a stiff neck, or a muffled voice.

Vendor's software report is attached to the EHR encounter. The report generated by vendor's software is a PDF file containing a color coded medical history for easy scanning, clinical decision support info, the patient report, and text based patient

encounter notes. This PDF is received as an email when patient submits the case, and can be attached to the patient encounter notes.

Patient reports contain case and clinic specific patient education material. The patient report contains a case assessment statement, guides on duration of the suspected disease (s), signs of worsening disease, next steps, and home remedies for symptom relief. For example, the following is part of what a patient with suspected flu outside the effective treatment window would see in the case assessment section: "*While there are medications that are effective for the treatment of influenza, that treatment is most effective if given during the first 48 hours of the illness and you are outside of that treatment window*." *Customization*. Vendor's software allows clinics to customize reports based on the case specifics. For example, for patients requiring urgent evaluation such as being short of breath at rest, a list of preferred urgent care centers was presented in case the clinic was closed. The medical protocols could also be customized so long as the changes remained consistent with well regarded medical guidelines and standard of care. For example, if flu testing is not available at a clinic, then it would not be mentioned in the reports and the next steps would be modified to account for that. Due to the inaccuracy of flu tests, not utilizing flu testing at a clinic is still consistent with standard of care.[10] Currently, the availability of flu testing is the only customization which changes the skip logic of the software. In our clinic, flu testing was not available.

EHR implementation. The design and implementation of the EHR link to vendor's software took 14 hours of clinician staff time, and 14 hours from the IT support staff. Working out the flow and wording for various dialog boxes took the most time, with the actual coding being a fraction of the total implementation time.

Measures

We decided on measuring the following 7 measures:

1. Number of patient usages

This indicated to us whether the tool was used, and if so to what extent.

2. Average patient interview time

This was a proxy for us for how easy the tool was to use for patients.

3. Triaging results

The next steps recommended by the software were as follows:

- *Urgent*. Same day evaluation recommended based on a red flag such as difficulty breathing at rest.
- *Lab*. Laboratory tests suggested to inform clinicians' decisions.
- *Call*. Call to clinician which can potentially save a clinic visit.
- *Visit*. Non urgent office visit for a physical examination.
- *Vaccine*. If not vaccinated, vaccination was recommended generally after recovering from current illness.
- *Home OTC*. Rest at home, and case specific over-the-counter medications for symptom relief.
- *Beyond topic*. Means the symptoms did not resemble the 5 diseases the software could sort. An example is just having nausea.

The software can recommend multiple next steps such as 2 lab tests (e.g. strep throat and mono), and vaccination once recovered from the disease. We use the one with highest acuity for our reporting, for example, in the case just presented it would be listed as lab. Physical examinations were needed in 2 cases: for ruling out strep throat, and pneumonia. For strep throat, generally a nurse call is suggested first. For possible pneumonia cases, urgent evaluation is suggested. We measured triaging results as to what percentages were triaged to urgent care, home care, call, physical examination, lab, vaccination. This would be an indication of how effective the tool was in reducing unnecessary visits.

4. Clinician opinion survey

The survey measures 10 variables as detailed in the results section. If clinicians do not like clinical tools such as the one presented here, their likelihood of adoption is much reduced.

5. After-hour usage

The clinic stops taking same day appointments at 3:30PM, and opens at 8AM on some days and 9AM on others. Clinic is closed on weekends, and on the days the university is closed. We categorized usage from 3:30PM to 6AM as night, and weekend or holidays as weekends. Night and weekend use was considered after hours. Since patients do receive some feedback regarding their condition from the tool, and since they get their care started by submitting their reports, we believe after hour usage has an impact on access.

6. Percentage of reports submitted

This would be another measure of adoption and impact on care delivery.

7. Demographics of users

Age and gender of the patients as self-identified by the patients.

Limitations

Wrong reports. The results of a report may be wrong since the answer to a question may be inaccurate (e.g. patient misunderstanding a question), or the software has bugs. We were worried a patient may not receive appropriate care due to these factors. To counterbalance that, we positioned the assessment tool in the appointments section of the EHR, and asked patients to send in all reports resulting in clinician review and calls.

Pigeon-holing clinicians. The treating clinician is the one who has ultimate authority and knowledge to make care decisions: the software is there to support and help this process. To avoid restricting clinician choices, we carefully chose our language to patients, and do

not show to patients "consider" next steps, i.e. those which some clinicians may choose to do and some may not.

Generalization

The prerequisite to replicate our study is availability of a patient portal including ability to make online appointments and attaching patient notes. There also needs to be an email account where the reports are sent to, and availability of clinical staff to call back patients. The required changes to the portal's appointment section took 28 hours of staff time for us. Since the third party software we used is commercial it should be accessible to other clinics as well. If these requirements are satisfied, it is reasonable to expect our results will generalize to other primary care settings, especially those closest to ours, for example clinics serving mostly adults.

Analysis

1. Number of patient usages

Estimating unique usages. Given vendor's software usage data, we tried to estimate unique usages by eliminating apparent multiple attempts by the same patient, usage by staff, or very quick usages which we deemed as unlikely to be a real patient case. This process was mostly manual.

Usage results. We used statistical software R for our analysis. The main results were:

- *144 usages in 120 day pilot period for patient population of 3961*. We had 144 unique usages as defined above within the 120 days of the pilot study. Since the clinic serves around 3961 patients, this amounted to 3.6% of the patient population using the tool assuming our estimate of unique usages was correct and each patient used the tool once in this period.

2. ***Average patient interview time***

Average interview time was 119 seconds, with the range being [40, 374] and standard deviation of 56 seconds. We removed one outlier of 1631 seconds from analysis, as it seemed like the patient had left the tool and later came back to it.

3. Triaging results

The detailed results are given below. Table 1 contains detailed triaging produced by the tool.

Table 1. Triage results given by the tool.

Beyond topic	1	1%
Home OTC	71	49%
Vaccine	8	6%
Call	17	12%
Lab	13	9%
Visit	2	2%
Urgent	32	22%

Figure 2 shows the tool generated triage results graphically. The tool triaged only 36% of patients for calls, regular and urgent visits. Note that all patients were contacted by a clinician regardless of the triage results.

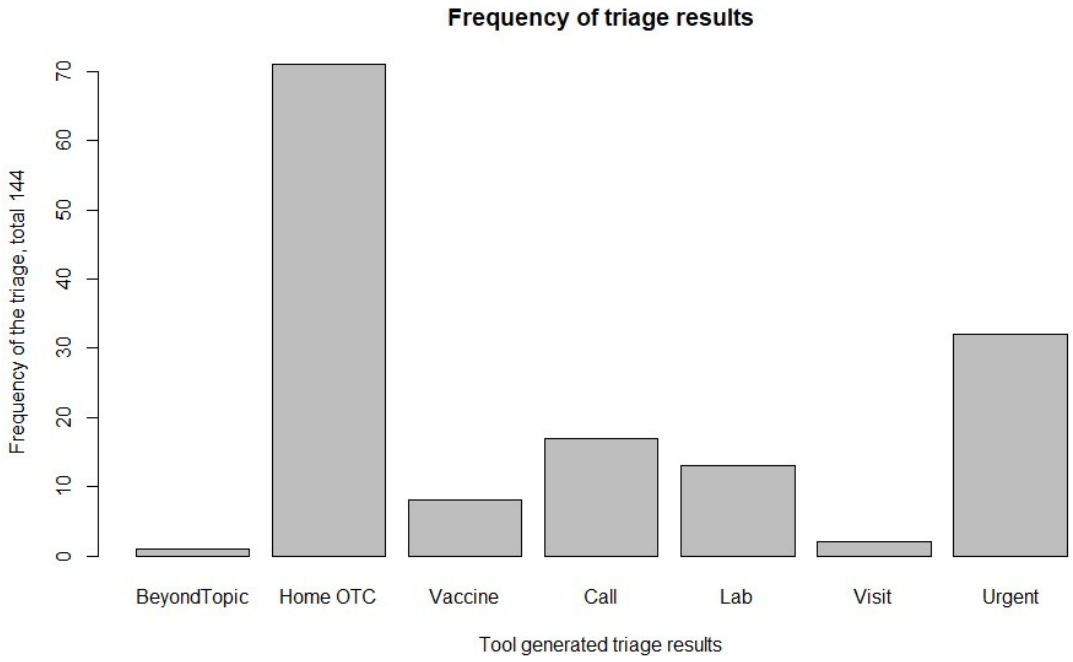

Figure 2. Displaying tool generated triage results graphically.

4. Clinician opinion survey

We ran an opinion survey of the clinicians roughly 100 days after the tool had been implemented. We asked 10 questions, which were all statements, and asked clinicians to rate them on the Likert scale: Strongly Disagree (**SD**), Disagree (**D**), Neutral (**N**), Strongly Agree (**SA**), Agree (**A**), and Don't Know (**DK**). Neutral means there are positives and negatives to the statement, and one's position is neutral. "Don't know" means one does not have an opinion right now.

We ran an anonymous physician report, and the results are presented below with SD being 1, SA being 5, '-' being DK, and empty cell being unanswered. We received responses from 8 out of 9 clinicians. In general, the opinions seem to suggest that the tool helped in reducing traffic, had good accuracy, was helpful in clinical decision making, and reduced the documentation burden. Clinicians reported receiving limited feedback from patients, but the ones they got were good. The detailed results are shown below.

Table 2. Clinician survey results: '-' means don't know, empty cell means did not answer.

Header	C1	C2	C3	C4	C5	C6	C7	c8	Responses	Score
Triage patients	3	5	4	4	5	5	5	4	8	4.4
Reduced traffic	-	4	4	4	5	5	5	-	6	4.5
Patient/clinician communication	-	4	4	4	5	5	5	3	7	4.3
Patient reports helpful	4	-	-	-	4	-	5		3	4.3
Accuracy	4	4	4	4	4	-	4	-	6	4.0
Helpful in clinical decision making	-	4	4	4	5	5	5	-	6	4.5
Documentation help	4	4	-	5	5	5	4	-	6	4.5
Clinician reports	-	5	-	5	3	5	5	-	5	4.6
Refer to colleague	3	5	4	-	5	5	5	-	6	4.5
Patient's opinion	-	-	-	-	5	-	5		2	5.0

The average across all questions was 4.5. The exact text of the questions in the questionnaire follows.

Table 3. Exact text of clinicians questionnaire.

Header	Question
Triage patients	DxTreat software was helpful in triaging patients
Reduced traffic	DxTreat software helped in keeping patients who could be cared for at home not visiting the clinic
Patient/clinician communication	DxTreat software helped in patient/clinician communication
Patient reports helpful	DxTreat patient reports were helpful to patients
Accuracy	DxTreat reports were medically accurate
Helpful in clinical decision making	DxTreat clinician reports were helpful in clinical decision making
Documentation help	DxTreat clinician reports reduced EHR documentation burden
Clinician reports	Clinician reports were easy to read
Refer to colleague	I am likely to refer DxTreat flu/cold topic to a colleague
Patient's opinion	Patients who discussed DxTreat with me had a positive impression of it

5. ***After-hour usage***

The usage was 73 day time (6AM-3:30PM), 54 night times (3:30PM-6AM), and 17 weekend and holidays. Overall, 49% of usage was after hours. Figure 3 displays this data graphically.

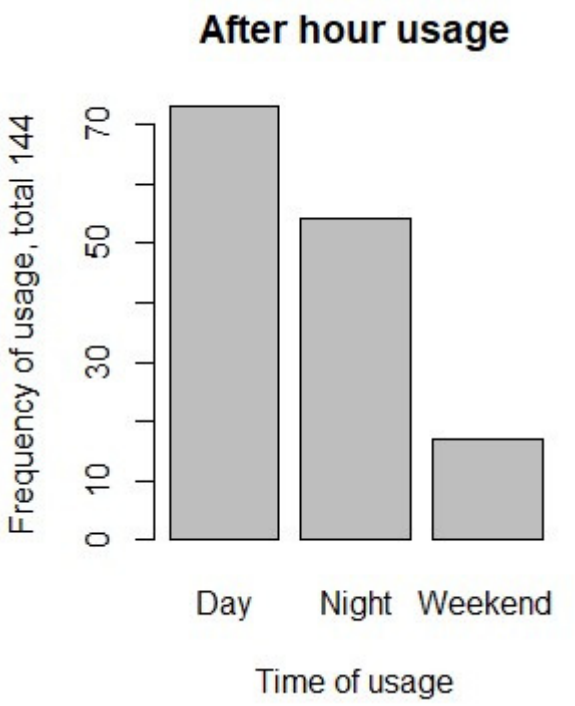

Figure 3. Displaying usage by whether it was after hours, marked as Night and Weekend. 49% of usage was after hours.

Usage vs CDC reported ILI activities for clinic's state. Figure 4 attempts to capture the relationship between influenza like illness (ILI) activity levels for clinic's state as reported by CDC and software usages on a weekly basis. As shown in top right hand plot, while there is a correlation between the 2 variables, there is significant variation in predicted regression line and actual values, thus making it hard to predict clinic loads for ILI type illnesses based on ILI activity levels.

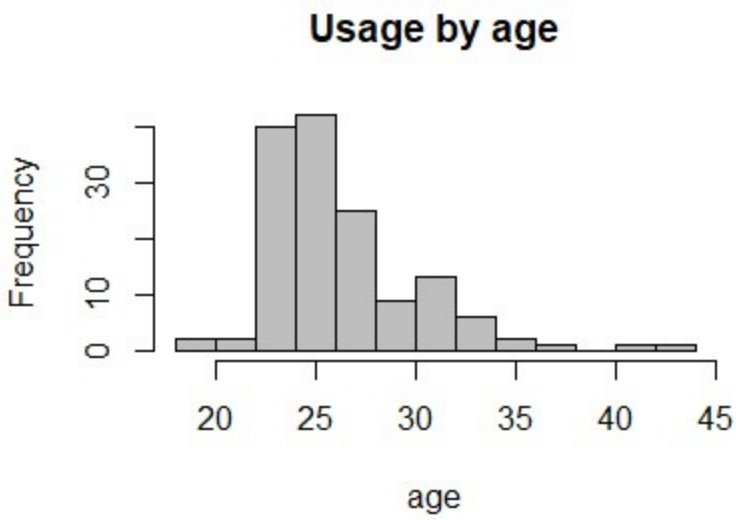

Figure 4. Full histogram of age of the user with mean age being 26.76.

6. Percentage of reports submitted

84% of generated reports were submitted to the clinic. Since users were anonymous, we do not know whether the 16% who did not send in reports did not seek care, seeked care without attaching the report, or contacted the clinic for making an appointment.

7. Demographics of users

Average age of the users was 26.76 with range of [14, 43] and standard deviation of 3.8. Figure 5 gives the full histogram of the users' ages.

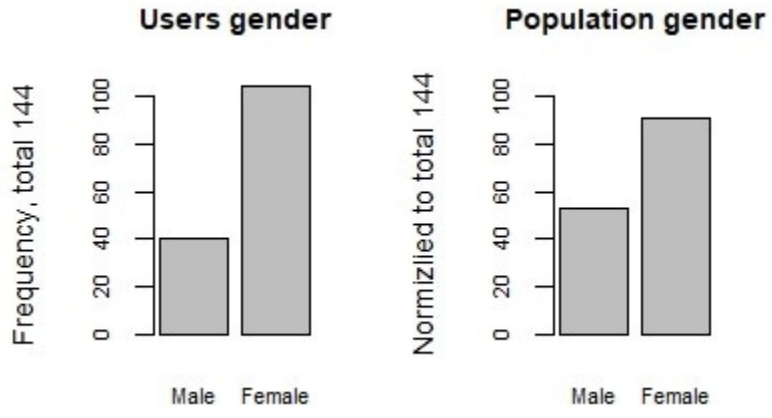

Figure 5. Gender of users: 28% males (trans. man counted as male), 72% females. Patient population is 37% males, 63% females.

Figure 6 shows the gender distribution among the users, where 28% of the users were males versus being 37% of the total population.[19]

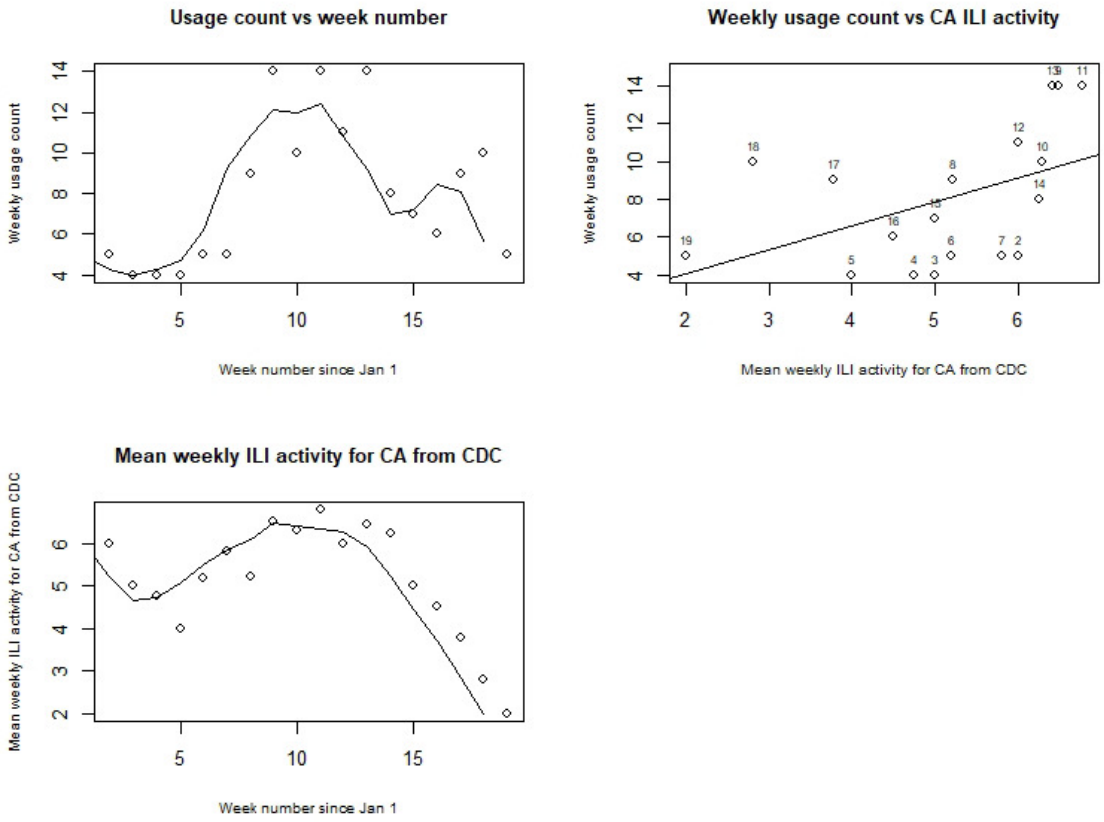

Figure 6. Exploring relationship between weekly usage data for the software and influenza like illnesses activity levels reported by CDC for California. The left hand plots use smoothing curves with ¼ of data points, top right one shows regression line and has week number as labels.

Discussions

Key findings. Offering an intended medically accurate computer based implementation of protocols for five upper respiratory diseases for home use was fast for patients to use (119 seconds average interview time), had good patient usage (with usages amounting to

3.6% of people the clinic serves in its first 120 days of introduction), and was well received by clinicians.

Notes on accuracy. The accuracy of the tool was rated as good and not great. We are not aware of significant bugs in the software, and while twenty software improvements were made as the study ran, only seven were to the skip logic which generates recommendations for the next steps. One of those seven was minor, i.e. not asking an irrelevant question. One was strengthening the language from "consider flu" to "likely flu". Two had to deal with non-respiratory cases where the software had no good next steps to recommend, and the language was strengthened around such cases. Three had to deal with sore throat and mono: reminding clinicians to retest for mono if within first two weeks of infection, recommending clinical evaluation in some cases of severe sore throat and no fever, and considering strep throat in cases where flu looks very likely but strep is also possible. One comment we got on our clinician survey was:

> "Sometimes what the patient checked and what they told us in person did not match, i.e. 'slowly over 3-5 days' is less helpful than 'been sick for 3 weeks'".

We suspect the "good" and not "great" accuracy comes mostly from a two minute computer based interview not being able to get the full picture of the patient's case. There will be software changes which will help improve our case understanding and therefore accuracy. However, there is likely a point of diminishing returns, and attempts to improve accuracy will result in harder to use software.

There was a mono case where the patient had noted only mild fatigue. The software recommended only strep and not mono testing since fatigue was not pronounced. Strep test was negative, and the final diagnosis was mono. We are evaluating whether a software change is needed in such cases, or whether that should be left to clinicians after they interact with the patients.

Implication of results. If this result generalizes to other topics and settings, it will be an important tool for primary care clinics to help manage care for the patients while improving their clinicians' morale.

Measuring outcomes in future research. It would be worthwhile if future work focused on effect of procedure on outcomes: cost, quality, access, patient and clinician satisfaction. Our clinician opinion survey is a starting point for measuring clinician satisfaction. Another interesting outcome to measure is elapsed time from patient contacting the health system to being contacted (text, call, video, visit) by a clinician. This can perhaps be used as a proxy for measuring clinical outcomes. Patient surveys may also be used to measure patient satisfaction. An interesting outcome to measure is percentage of patients booking an appointment for cold/flu through the patient portal who used the tool. Longer term, we have to measure whether clinicians become disengaged as the software provides some automation, or become more engaged as the software is helping with more mundane tasks allowing clinicians to focus on challenging cases and deeper patient education.

Limitations of the study. Our study was carried out in a small clinic involving only nine clinicians serving graduate students in a health related field. A larger setting with more diverse patient population may reveal phenomena we did not observe. The scope of our study was also limited, and many important measures as detailed in an earlier section, were not studied.

EHR integration. One clinician noted that it was not easy to see in the EHR whether the patient had completed the interview, and this must be made more prominent.

Additional topics. Many other non-urgent primary care conditions can be covered using a similar approach to the one described here.

Patient follow up. An important additional future software feature is the ability to follow up with the patient to ensure progression of the disease is as expected, and if not, alerting the care providers so that treatment adjustments can be made.

Conclusion

This procedure is a novel tool in delivery of primary care, which improves access to care, was well-liked by clinicians, was fast for patients to use, and appeared to reduce

unnecessary visits. It also has the potential of improving quality of care. We were able to integrate it as part of our clinic's operations, and help improve management of our flu/cold patients during the cold/flu season. We look forward to using the tool in the future, and also expand to other topics such as STI screening and UTI.

Declaration of interest statement

Ramin Hojati is an employee of DxTreat Inc. Tom Richards is a consultant to DxTreat.

IRB and funding

We contacted the UCSF Office of Ethics and Compliance, Human Research Protection Program regarding the project. It was deemed as a QI/QA project aimed at improving care for students with flu, and therefore, and not subject to their review. This project did not receive any funding.

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