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Knowledge Creation Using Artificial Intelligence: A Twin Approach to Improve Breast Screening Attendance

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***Abstract*—Knowledge Management (KM) is rapidly becoming established as a core organizational element within the healthcare industry to assist in the delivery of better patient care. KM is a cyclical process which typically starts with Knowledge Creation (KC), progresses to knowledge sharing, knowledge accessibility and eventually results in new KC (in the same or a related domain). KC plays a significant role in KM as it creates the necessary "seeds" for propagating many more knowledge cycles. This paper addresses the potential of KC in the context of the UK's National Health Service (NHS) breast screening service. KC can be automated to a greater extent by embedding processes within an Artificial Intelligence (AI) based environment. The UK breast screening service is concerned about non-attendance and this paper discusses issues pertaining to increasing attendance.**

I. Introduction

The UK's National Health Service (NHS) is presently reorganizing its information and communication technologies (ICT) infrastructure so that information and knowledge can be better shared with stakeholders. The Connecting for Health (CfH) agency is delivering the National Program for Information Technology (NPfIT), one of the largest healthcare-related IT projects in the world [1]. The core issues being addressed by this project are the efficient and effective flow of information and knowledge across care pathways for better patient care. The application of contemporary knowledge is vital to improve health and combat diseases [2].

In a knowledge aware healthcare scenario, Knowledge Creation (KC) should be a fundamental activity. New opportunities to create knowledge have to be properly instigated so that service intensive businesses such as healthcare can benefit [3].

Breast cancer has been identified as a high mortality medical condition in the western world [4]. Many western countries, including the UK, have initiated mammography as a primary diagnosis tool delivered by way of national screening programmes. In spite of such numerous efforts, uptake has not reached the expected levels [5].

Our research aims to improve attendance for breast screening by way of two distinct approaches (fig. 1) through interventions by General Practitioners (GP). The first approach focuses on pre-screening through predicting non-attendees. The second approach would be to use post-screening results of non-attendees generated at the end of the screening episode [6]. The first approach employs an AI-based algorithm (which embeds KC activity) to create knowledge through various predicting factors. The second approach relies on knowledge generated through a bespoke software program written to capture non-attendees from results generated by the National Breast Screening Software (NBSS).

Both of these approaches rely on a GPs ability to intervene provided they have an opportunity.

II. Knowledge Cycle

Initiating the knowledge cycle leads to KC which in itself results in tacit knowledge (knowledge which resides in one's mind). This knowledge has to be shared with all probable knowledge users once it has been converted into explicit knowledge, i.e., knowledge which can be shared and disseminated. This process of creating and sharing should be well established within the organizational framework and will lead to new opportunities and avenues which can be exploited through the leveraging of knowledge [7].

A. Knowledge Creation (KC)

Various stimuli are mandatory in order to instigate KC. As KC is fundamentally a cognitive process manifested within the human mind, a favourable environment is required to create new knowledge. Modern organizations need to fine

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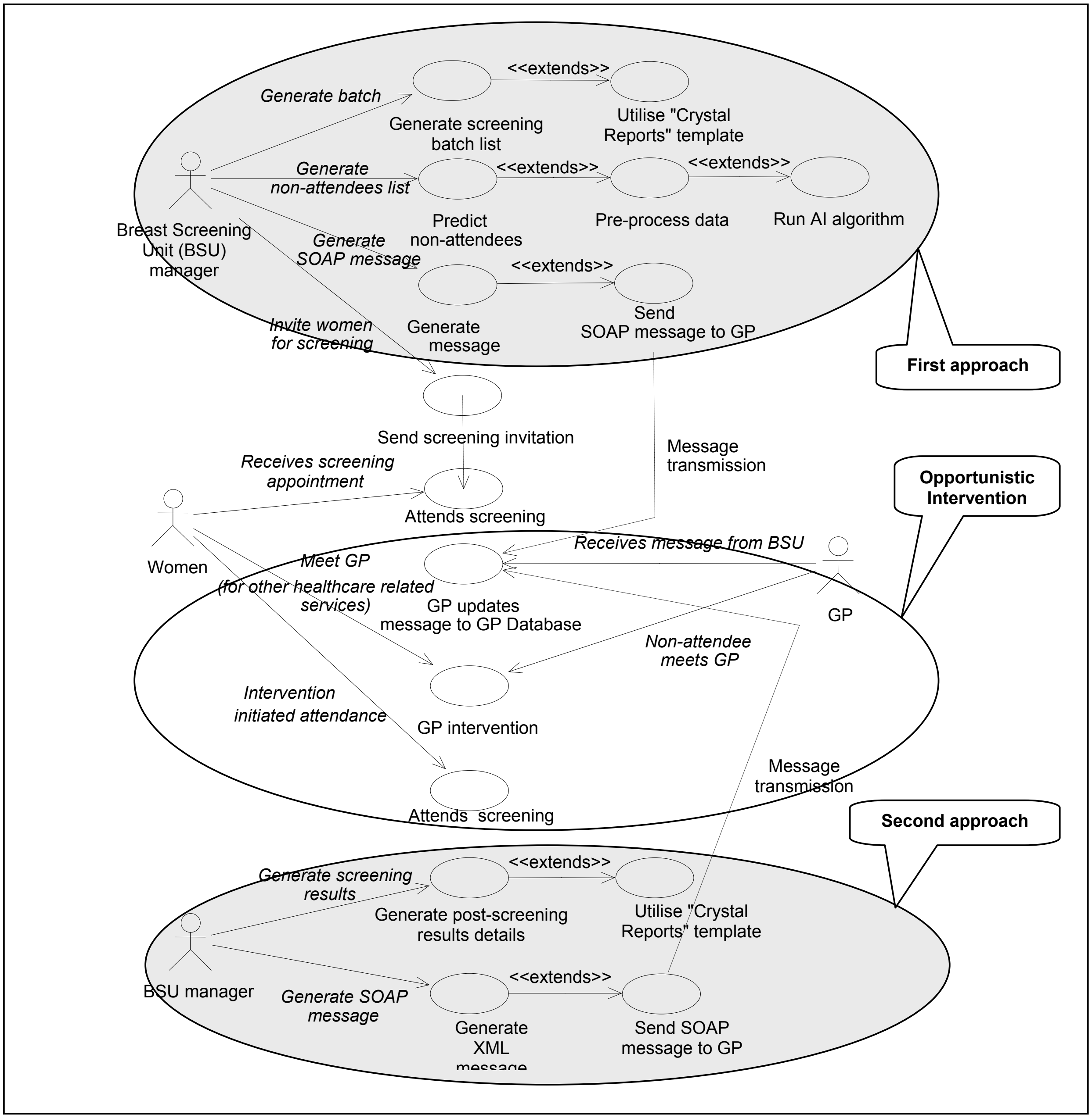

Fig. 1. Actions involved in the two approaches to increase screening attendance by GP intervention

tune themselves for creating this sort of culture. This aspect could be best handled only by an organizational strategy that has faith in efficient KM procedures. The change program currently taking place within the NHS is rapidly moving towards this ideal [3].

The NHS Connecting for Health program places emphasis not only on creating the necessary knowledge, but also provides an infrastructure to effortlessly share knowledge within the NHS' various clinical pathways [6].

Our current research is aimed at automating the process of prediction (the KC process) and efficiently sharing predicted knowledge with primary care deliverers (GPs). Knowledge Creation for this research is illustrated in Figure 2.

The *insight* stimuli comes from the initial idea (a human component) to use automated prediction as an effective tool to counteract non-attendance.

Explicit knowledge acts as a proactive stimulus via knowledge derived from earlier research [8] and through literature review.

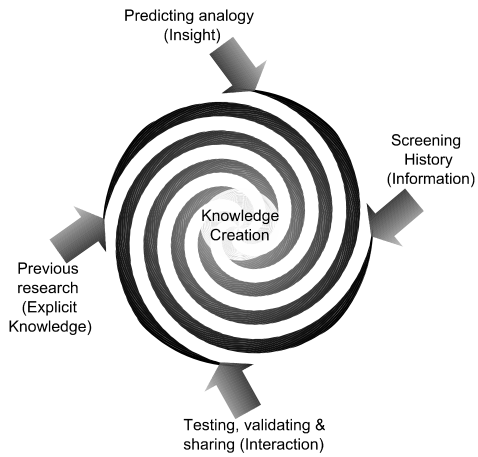

Fig. 2. KC in predicting screening attendance

The *Information* stimulus refers to the screening history of women and demographic details collated from various sources.

The testing of the AI-based algorithm, validation with various statistical techniques and publication of findings provides the opportunity to share the knowledge with peers which formed the *interaction* stimulus.

A. KC through AI-based Neural Network (ANN)

The knowledge created by the various stimuli should not be a one time process (where knowledge created would be static). Our current work envisages the use of an AI-based Neural Network (ANN) to capture the KC process. In this way, automation can be implemented within the existing breast screening process; the knowledge created is in the form of screening attendance prediction.

The ANN has been implemented using Open Source technologies (Java environment). Based on a simple feed forward back propagation structure, the implemented ANN works via a Java-based server program. It uses historical screening data and demographical information by way of Townsend deprivation scores [8] as predicting factors. This forms the dataset that is presented to input neurons. The middle layer (also known as the hidden layer) is connected to every other input neuron and to one output neuron. The output neuron remains at "Zero" when a woman is predicted as an attendee and turns to "One" when she is predicted as a non-attendee. Earlier research has confirmed that one hidden layer will suffice to map any multivariate type of input domain to the output domain[8]. During the training stage, the error function is fed back through the network from the output neuron.

The proposed knowledge capture is implemented using the architecture shown in figure 3. The structure of the ANN can be best described as having 210 neurons each in the input layer and hidden layer; the output layer has 1 neuron. This simple back propagation based ANN is adequate for testing the above knowledge capturing event.

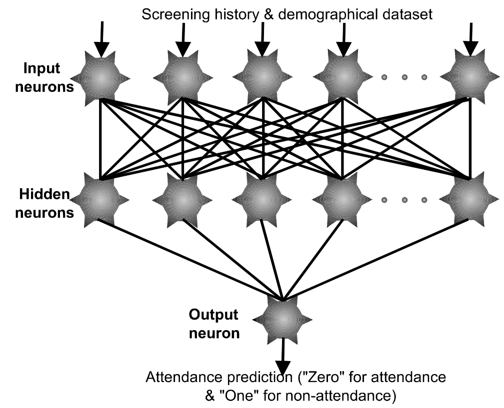

Fig. 3. KC captured within a ANN

B. Post-screening KC

The second approach is based on post-screening knowledge generated by the software. Once the screening batch is completed, the NBSS software creates the attendance list; this knowledge is captured by the automated software related to the screening attendees at post-screening stage (approach 2 in figure 1). This approach automatically identifies the non-attendees and generates messages which are used to share this knowledge with GPs.

C. Actions involved in the two approaches

The first approach has the following main actions: the Breast Screening Unit (BSU) manager generates the incoming screening batch. This batching activity is executed on a three year recursive cycle in such a way that it includes the whole population covered by the screening unit. When the batch list is generated by the NBSS software, the manager utilises a report template to export the batch list as a flat file saved in a suitable folder located in the BSU server.

The next action is to generate the non-attendee list through the automated software (coded in Java). The software component is resident in the BSU server and is accessed by the client program via a Graphical User Interface (GUI). The software prompts the user to point to the location of the flat file (already created by the template and stored in the server hard drive). Once the file is located, the pre-processing software will automatically generate the required predicting factors and normalise the data.

The User (via the GUI interface) points the ANN to the location of the historical data (in the flat file) to train the network. Once the training is completed, the net is pointed to the normalised data so that prediction can be initiated. Any errors during the pre-processing, training and the actual prediction activities are stored in individual log files which can be viewed at a later point in time for feedback.

The GUI gives the option to the user to initiate the Simple Object Access Protocol (SOAP) message. The message body is instantiated with reference to an eXtensible Markup Language (XML) schema definition designed on the Health Level 7 (HL7) version 3.0 standards. The XML message is called upon by the software to generate the SOAP envelope and attaches the XML message to the SOAP body with a digital signature (for security). The Java-based web services technology provides encryption to make the message completely secure. The message is transmitted via web services to the GPs' mailbox server.

Once the GP server connects to the mailbox it downloads the messages and the GP's software automatically updates the XML content to the women's records after proper decryption and verification of the digital signature contained in the SOAP message.

Meanwhile, the BSU executes its routine process of inviting the women by dispatching an appointment letter (with details of the screening date and time). For predicted non-attendees, the knowledge of non-attendance generated by the ANN is now available to the GP. When the woman meets the GP for other healthcare related services, GPs can proactively initiate an opportunistic type of intervention thereby increasing the likeliness of improving screening uptake.

The second approach starts after the actual screening batch. The NBSS creates the results for the last batch and utilises a report template to export the batch list. The user (via GUI) points to the location of the flat file again to segregate the non-attendees. Once segregation is completed, a new SOAP message is generated using the same procedure as before and transmits it to the respective GPs. This again updates the woman's medical record of real non-attendance, thereby providing another opportunistic type of intervention to the GPs.

III. Conclusion

The efficacy of KM in healthcare and the importance of the KC component in the knowledge cycle have been highlighted in this paper. Even though KC is a human trait, a massive amount of attributes are involved; the KC process would justify the use such technologies as AI to capture the KC process. This would not only provide a consistent, error-free KC process but also would open up new ways to automate the KC for recursive cycles over time with a satisfying degree of repeatability. We postulate that most future healthcare projects could benefit from focussing on clinical and healthcare knowledge-based issues.

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