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Overcoming the interruptible nature of allergy treatment through applying knowledge management principles:

A Trip from raw knowledge to transferable wisdom

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Abstract

Rates of food allergy diagnosis in children are increasing exponentially in developed countries; in Melbourne for example, 20% sensitisation and a 10% challenge in 12 month old infants were confirmed (Osborne et al., 2011).

As allergy services are stretched, patients are seen by different allergy practitioners, thus significantly challenging uninterrupted allergy care. Specific problems include prolonged waiting times for food allergy reviews; and the lack of a clear and comprehensive documentation of serial allergy test results over time in a consistent format. To address these issues this study will develop an electronic solution for use by both allergists and their patients to ensure prospective accurate and secure collection of skin prick test [SPT] or serum specific IgE [ssIgE] test data for long term follow-up of patients with food allergy, and applying intelligent tools and techniques to the developed database to enhance the ongoing care of children with allergies including developing tailored preventative strategies.

Keywords: Allergy, Intelligent tools and techniques, skin prick test, serum specific IgE test, database, knowledge management

1. Introduction

Rates of food allergy diagnosis have increased exponentially in recent decades in developed countries (Wang & Sampson, 2011). Recent data generated from the local Healthnuts study has identified an increase of 20% sensitisation and a 10% challenge confirmed food allergy rate in 12 month old Melbourne infants (Osborne et al., 2011), the picture of allergy in Australia in general looks even more worrying (Abels, Cogdill, & Zach, 2004). According to a report made for the Australasian Society of Clinical Immunology and Allergy (ASCI) in 2007, there were 4.1 million Australians (19.6%) having at least one allergy, and the average Australian allergic person with 1.74 allergies, forecasting of 70% in the number of Australians with allergies affected from 4.1 million now to 7.7 million by 2050, and an increased proportion affected from 19.6% to 26.1% if the trends back then continued (Access Economics Pty Limited, 2007).

The financial impact of allergy treatment is high as well. 7.8 billion Australian dollar was the calculated cost of allergies in Australia in 2007. This is due to different interrelated factors like lower productivity ("presenteeism" \$4.2 billion), direct medical costs (\$1.2 billion), lower employment rates (\$1.1 billion), absenteeism and lost household productivity (\$0.2 billion) and premature death (\$83 million)(Access Economics Pty Limited, 2007; Sampson, 2002).

Food allergy diagnosis is confirmed by a positive allergy test (Skin Prick Test [SPT] or serum specific IgE [ssIgE] blood test) in conjunction with a history of an immediate allergic reaction to that food. However, screening allergy testing is frequently performed in the community prior to a patient having known exposure to a food allergen, particularly in at risk patient groups eg. patients' with Atopic Dermatitis (AD). The size of the SPT or level of ssIgE are used as guides as to the likelihood or otherwise of clinical food allergy (Hill, Heine, & Hosking, 2004).

The gold standard for food allergy diagnosis in this setting is by a physician supervised food challenge.

Most food allergy in childhood resolves with time (eg. egg, milk, wheat, soy), however allergies to peanut, tree nut, fish and shellfish tend to be ongoing into adult life in up to 80-90% of patients. To follow up for the development of potential clinical tolerance patients are re-evaluated every few years with repeat allergy testing (either SPT or ssIgE) (Peters, Gurrin, Dharmage, Koplin, & Allen, 2013). The size of the SPT or level of

ssIgE are used as guides as to the likelihood or otherwise of the development of clinical tolerance. Serial allergy testing over several years is common before the allergy test (SPT or ssIgE) is at a level where it may be considered appropriate to proceed with an oral food challenge (Sampson, 2002).

It is not an unusual clinical practice for clinicians to provide patients with a copy of their SPT results each time the test is performed as well as keep a record of the test in either written or electronic form in their patient database. As allergy services are currently stretched, there are frequently prolonged waiting times for food allergy review, particularly in the public sector. It is not uncommon for patients to be seen by different Allergy Practitioners for follow up testing in the longer term. In the interim patients are frequently encouraged to attend their general practitioner for food allergy follow up that may include intermittent evaluation of yearly or second yearly ssIgE to the food allergen(s) in question. In the event that these levels are low or approaching negative re-referral for follow up and consideration of formal inpatient challenge may be appropriate. In this situation it is not uncommon that previous test results are not readily available for comparison (Chan et al., 2015). There is some evidence to suggest that the rate of change in SPT size or ssIgE levels over time may help in predicting the development of tolerance.

Provisioning allergy care seems to lack accurate and reliable data within and between different allergy care providers. According to Prescott et al. (2013), more than 57% of 89 countries around the world had no food allergy prevalence data of any kind, and just 10% of these countries had this sort of data.

Thus, analysing the current approaches to treat allergy (Nieuwenhuizen & Lopata, 2005) shows a clear gap in this area. This mainly relates to the lack of documenting serial allergy test results (both SPT size and ssIgE levels) over time in a readily available and consistent dataset by both allergists and their patients. Offering this possibility would be an invaluable tool in the long term management of these patients. Thus, this study aims at developing an electronic solution for use by both allergists and their patients to ensure prospective accurate and secure collection of SPT and ssIgE data for long term follow-up of patients with food allergy.

Allergy Specialists (EAS) at the study site was established in 2010 to provide a comprehensive service for children, adolescents and adults with allergic and immune disorders including the long term follow up and management of patients with food allergy. EAS is the first such service to provide safe inpatient food challenges in the private sector in Australia. To date EAS has performed over 2000 food challenges to confirm or refute the development of tolerance to previously identified food allergens with a positive challenge rate of 20%. These challenges are not without risk with

anaphylaxis occurring in 2% of all challenges currently performed at the study site, highlighting the importance of a service with expert staff equipped to deal with potentially life threatening anaphylaxis (Metcalf, Sampson, & Simon, 2009; Prescott et al., 2013).

2. The Theory of Knowledge Management

To solve the dilemma of increasing rates of allergy, and its financial burdens, this research adopts the approach of Knowledge Management (KM). This theory deems appropriate to back this type of researches, as it aims at solving current business challenges by increasing the efficiency and efficacy of core business processes, while simultaneously incorporating continuous innovation (Wickramasinghe, Bali, Lehaney, Schaffer, & Gibbons, 2009).

Knowledge management is an emerging management approach that aimed at responding to the increasing need to better management of the ever increasing data stored in databases or even information that is being exchanged throughout different and complex networks (Geisler & Wickramasinghe, 2009). Primary drivers for KM include: 1) the global trend to invest in information and communication technology since late 1980s, and 2) the dilemma of lack of tools that domesticate the expertise within the organizations when senior executives leave their organizations (Wickramasinghe et al., 2009).

Knowledge management deals with distinct, but related, concepts, starting from data (raw knowledge), to information (data arranged into a meaningful pattern, to knowledge (contextualized information, and wisdom, upon its existence beyond knowledge there is a wide agreement (Wickramasinghe et al., 2009; Wickramasinghe & Von Lubitz, 2007).

2.1 Knowledge Management for Healthcare

With the ever increasing volume of data being produced daily in the electronic medical records (EMR) and clinical databases, knowledge management approaches provide a tools-rich platform to perform pattern-identification tasks, such as detecting associations between certain risk factors and outcomes, ascertaining trends in healthcare utilization, or discovering new models of disease in populations (Holmes et al., 2002).

In their comprehensive assessment of applying knowledge management in the healthcare industry, Wickramasinghe et al. (2009) noted that the gap between data collection and data comprehension and analysis is becoming more problematic, given

the increased volume and complexity of clinical data, which, in on one or other, reflects the complexity of the healthcare itself (Wickramasinghe et al., 2009).

2.2 The Application of Knowledge Management on this Study

Utilizing the tools, tactics, and techniques that knowledge management offers is deemed appropriate for this research for the following reasons: First, the designed data base is expected to produce high volumes of data on different types of allergy in different age groups. Not only is the volume demanding, but also the complexity of the produced data is an issue. Those two factors combined, make the use of knowledge management prudent to maximize the benefit of using the designed database. Second, knowledge management will help bridge the gap between data collection as a routine procedure and data comprehension and analysis as an innovative and iterative process. This is highly important based on the explanation aforementioned.

Third, it will help clinicians to better understand their patients' data with less effort and time, which, in turn, increases the efficiency and efficacy of their daily operations.

Fourth, the aim of this study is to create a reliable and exchangeable knowledge among different allergy treatment providers, rather than merely creating the database. This is the core interest of knowledge management approach, by moving from raw knowledge (data), which is much context-dependent, to knowledge and then wisdom, which are much more context-independent (Wickramasinghe et al., 2009).

3. The Solution

Such an electronic database will ensure prospective accurate collection of allergy test results over time. In doing so, this will enable ready access to these results by both patients and clinicians at each point of contact with health service providers to aide in the long term follow-up and management of these patients with food allergies. The database will be designed to alert patients to appropriate timing for re-evaluation and potential consideration for food challenge; thereby, allowing timelier introduction of food to which they had previously reacted or had allergy test results predictive of likely true clinical allergy.

The longer term plan is to develop the database into a usable application for smartphone/ hand held devices increasing portability/usability and autonomy of patient groups with allergic disease.

4. Study Design Methodology

This research is exploratory, and aims at developing a tool to facilitate better allergy care. To operationalise this endeavour, a single case study methodology will be

adopted. The case study is the paediatric allergy clinic at one of the largest private hospitals in Melbourne Australia. A number of data collection and analysis techniques will be used during this study. As noted by (Yin, 2009), case study methodology is appropriate when embarking upon exploratory research. Further, we will subscribe to established qualitative data analysis techniques such as thematic analysis to analyse the qualitative data (Boyatzis, 1998; Vaismoradi, Turunen, & Bondas, 2013) while descriptive statistics (Bower, 2013; Woolson & Clarke, 2011) will be used to analyse the survey data.

The study has two distinct phases:

1) Designing the technology solution; the database,

2) Testing the fidelity and usability of the designed database. Key activities will include:

- Storyboarding with head of clinic to clearly understand needs and requirements.
- Investigating the possibility to securely store photos of results of skin prick tests with data.
- Creating an App that the clinicians can use to enter skin prick test data.
- Creating a secure encrypted database.
- Ensuring data is backed up automatically.
- Calculating the “mean” for each allergen.
- Generating a trend analysis for each patient.
- Creating a printout results to replicate the existing Skin Prick Test.
- Printing out an informative results sheet for parents/patients.
- Testing and validation of the product.
- Testing the fidelity and validity of the database will be done over a 3 month period through a two-armed study, during which patients who agree to participate will be randomly selected into the technology arm (database plus standard care protocols) or standard care arm (current practice method) respectively. Clinicians will then perform the required allergy testing and consult using respectively the technology solution or standard care approach. We note that for the technology arm the research assistant will still complete the paper work as directed by the clinician so at all times all patients will at a minimum receive the same standard care. On the completion of the trial a focus group with the clinicians will be conducted to capture their insights on the usability of the proposed system, as well as their comments, recommendations and other feedback. Fidelity of the system will also be assessed by comparing standard care results with the technology arm results.

- To ensure the validity of the data collected through the focus group, an online survey will be administered at the conclusion of the focus group to ensure data triangulation.

5. Setting and Participants

This is an exploratory research study with a single case study in one of the largest private hospitals in Melbourne Australia.

During which both qualitative and quantitative data will be collected from three different sources:

1. Initial discussions with the head of a Melbournian allergy clinic to specify the initial design requirements based on the standard allergy care protocol.
2. Randomly selected de-identified existing patients' records from this clinic to help establish the main structure of the proposed system.
3. A focus group with up to 5 clinicians from this clinic to have their insights on the use of the proposed system, recommendations, and comments on and about the prototype once it is developed.

For data triangulation, an online survey to these clinicians will follow analysis of the collected data through the focus group. This survey will be designed and administrated using SurveyGizmo.

Participants will be invited via email and/or phone to join the focus group. They will be given a Plain Language Statement describing the research using simple English language and a consent form to guarantee anonymity while participating in the focus group.

6. Data Collection Plan and Techniques

Initial discussions have been conducted with the head of the allergy clinic. Through these discussions we have established that the need for an electronic database with intelligent analysis tools and techniques plus the mobile App is greatly needed. Patients' records will be randomly selected with full compliance with ethical requirements. This data will then be used to populate the developed database. The focus group will target up to 5 clinicians who work for the selected clinic. They are recruited based on their daily interaction with patients and their records. Those who participate in the focus group will be requested to complete a follow up survey for data triangulation. Patients who visit the clinic during the 3 month trial period will be asked if they wish to participate in the study (again subscribing to all ethical requirements) and if so will then be randomly selected into the respective arms of the

two arm trial (as described above). All patients will receive equal care and attention irrespective of their participation or not in the study.

Data will be collected using the methods of 1) De-identified patient records, 2) focus groups, and 3) an online survey (using SurveyGizmo). All patient data will be handled using standard Australian Privacy Principles; including using double de-identified data to ensure confidentiality and anonymity. In addition, all patient data collected will be disclosed only with participants' permission, except as required by law. All information will be stored securely at the study site in a locked office in a filing cabinet and /or password protected computer. Table 1 summarises data collection plan and techniques:

Table1. A Summary of Data Collection Plan and Techniques

Key Participants/Key Milestones	Participants/Records	participant numbers
Initial Discussions	Specialist doctor (allergist)	• 1
Patients' records	De-identified Patients' records (historical records) randomly selected.	• Patients' records: <= 50 records
Focus Group	Clinicians work in allergy care. This will be conducted after the solution is trialled	• An expert group: ~ = 5
On-line Survey	Clinicians work in allergy care. This will be conducted after the completion of the focus group.	• An expert group: ~ = 5

7. Data Analysis

This study is predominantly qualitative. Thus, we will employ standard thematic analysis techniques to analyse the data collected through the focus group. This can be done effectively using NVivo 10 qualitative analysis software (Bazeley & Jackson, 2013), which will also be used to identify design requirements from the discussions with the recruited allergist. For the survey, we will use Nvivo as well as some basic quantitative analysis such as frequency analysis. The online survey will be administered using SurveyGizmo.

8. The Study Initial Outcomes

Currently the initial project prototype has been developed using: HTML, CSS, PHP, JavaScript, MySQL, PHP My Admin. A local WAMP server is installed on the study site.

A temporary database is created with dummy data for this initial development and testing.

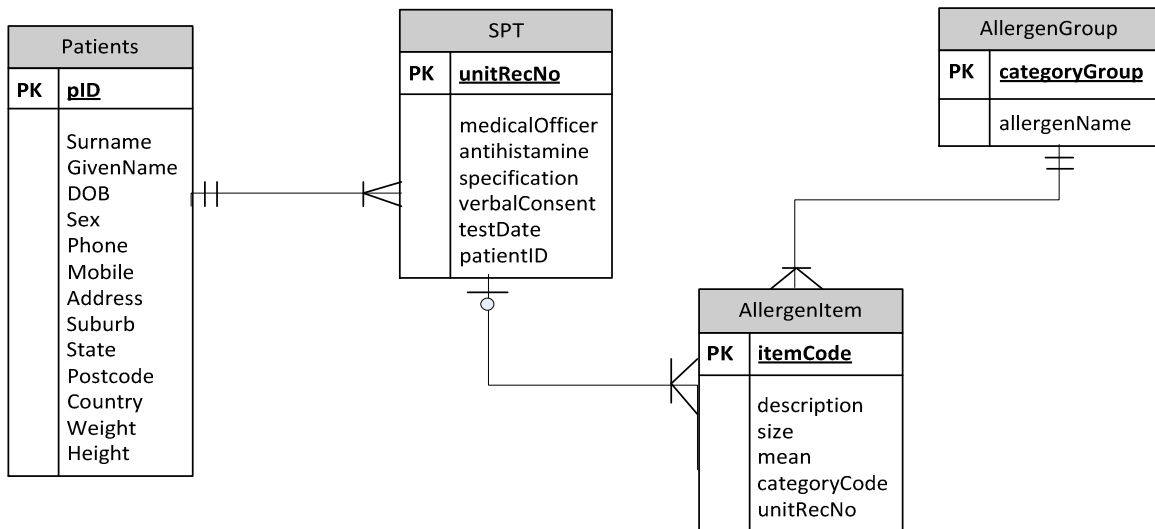


Figure 1. Allergy Database ERD

A proper database with real patient records/information must be imported and/or created for the next stages of the project development. The project progress is summarized as follows:

▪ **Requirements gathering**

Requirements gathering has already started. Project description, scope, and expectations are discussed in these meetings. Existing SPT forms and materials are gathered and stored in the research office.

▪ **Database**

A temporary database is created as the back-bone supporting system. The “allergyProject” database is stored on the standalone computer at the Research Institute and has the following details:

- users (userID, name, password)
- Patients (patientID, surname, givenName, DOB, sex, phone, mobile, address, suburb, state, postcode, country, weight, height)
- SPT (unitRecNo, medicalOfficer, antihistamine, specification, verbalConsent testDate, patientID)
- allergyGroup (categoryCode, allergenName)

- allergenItem (itemCode, description, size , mean, categoryCode, unitRecNo)

- **SPT – website**

SPT-website is designed as demonstrated in Figure 2. The following are the major categories of the SPT and/or sslgE allergy testings.

- Food
- Plants
- Nuts
- Grain
- Inhalants / Aeroallergens
- Pollens
- Latex Panel
- Insects
- Animals
- Controls

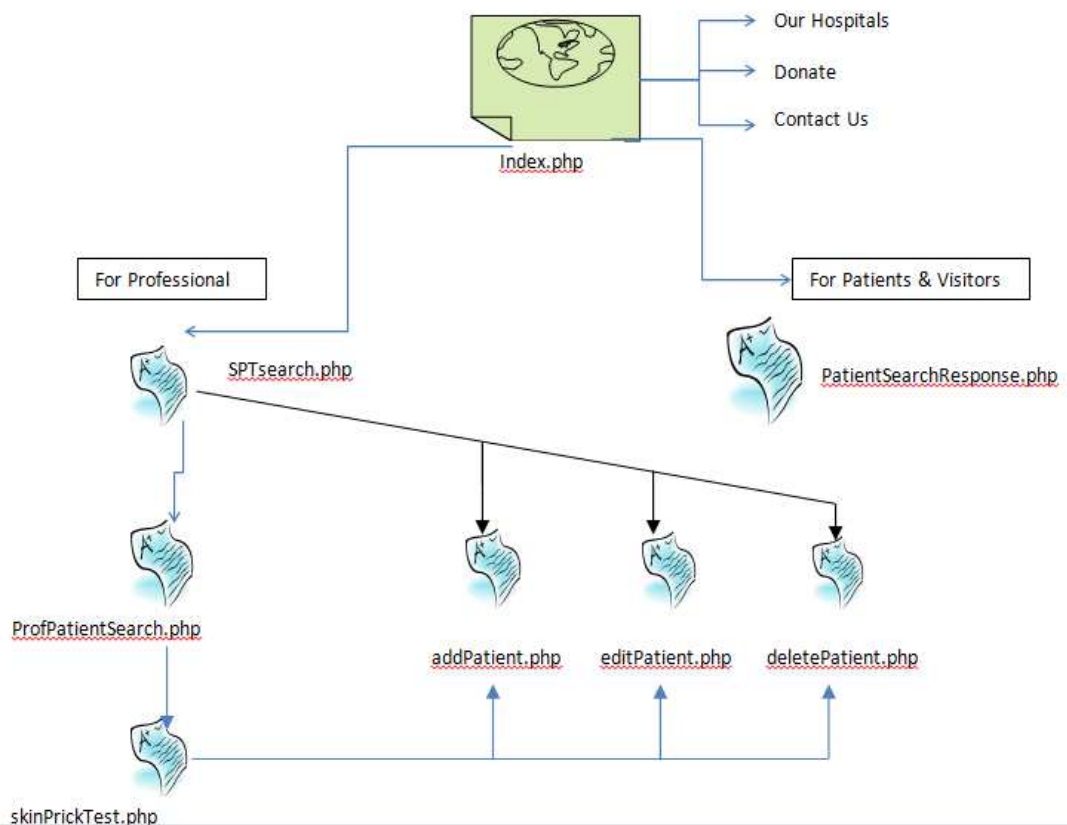


Figure 2. SPT – website

9. Discussion and Conclusion

This research has a number of implications for both theory and practice on achieving values, research and care quality. From a theoretical perspective it serves to extend many aspects of KM theory into the healthcare domain, which is a rich environment with data, information and knowledge. It is particularly useful for addressing the gap between data collection and data comprehension and analysis, which is becoming more problematic, given the increased volume and complexity of clinical data as pointed out by Wickramasinghe et al. (2009). This is expanded upon in our future work.

From the perspective of practice we highlight several key aspects as follows:

First, the product of this study can play a key role in keeping with the values this solution will enable patients to receive a better care experience. Furthermore, a solution like the proposed solution to provide superior allergy treatment and follow up for children will certainly enable healthcare providers to differentiate itself in this regard specially given that to the best of our knowledge this is a solution that has yet to be developed in other hospitals in Australia.

Second, this database has the potential to enhance the long term follow up of patients attending for comprehensive food allergy management at healthcare contexts. For example, this tool can generate much needed updated long term data on the natural history of food allergy from infancy, through to adolescence and adulthood.

Third, this project has great potential to be patented and commercialised again bringing kudos and financial benefits to healthcare contexts.

Fourth, this project will have benefits for pioneering both teaching and allergy areas at healthcare, as this is one of the first systems of its type in the Australian context, if any, to facilitate superior allergy care.

Further advancing outcomes are include developing the database according to agreed standards and through details discussions between clinicians, IT developers, and researchers will also help to develop rubrics for all such projects which are of importance in healthcare.

Most importantly, there will be instant and long-term clinical benefits by facilitating proactive and protective allergy care and management practices.

The next steps of this research will include empirical testing and also further focus on other aspects of KM including tacit knowledge and implicit knowledge capture.

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