# A preliminary study of the clinically useful life of digitally archived medical images Queensland Health Lawrence Sim<sup>1</sup>, Liam Caffery <sup>2</sup> and Ken Manthey<sup>3</sup> **Queensland** Government <sup>1</sup>Clinical and Statewide Services, Queensland Health, <sup>2</sup>Royal Brisbane and Women's Hospital, Brisbane. <sup>3</sup>Princess Alexandra Hospital, Brisbane.

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### **PURPOSE**

Medical images are used during a course of treatment which may extend from a number of hours to a number of years. This is referred to as the period of clinical usefulness [1] (clinically useful life) of an image. The clinically useful life is variable and influenced by a variety of factors including accessibility, modality and clinical condition. Image retention policy should consider the clinically useful life.

The use of picture archives and communication systems (PACS) — with their capabilities to log image viewing provides a rich information source for determination of clinically useful life of medical images.

There is considerable debate as to when images should be deleted from the PACS archive.[2] In some installations, image retention policy used for film-based archives has been directly applied to the digital environment. These policies were most likely developed when it was difficult or impossible to audit the clinical review of images and hence, may have little relationship to the clinically useful life of an image.



Chest Xray Plain (2354 cases) - First Time Viewed

In other facilities, the decreasing cost of digital storage media [3] has often been cited as a reason for storing medical images beyond the period of time they were stored in a film-based environment. However whilst the unit cost of media decreases, storage management costs — which are a product of the volume of information stored and the period of storage — increase.[4] These costs can be further exacerbated by data migration from obsolete media to up-to-date technologies.

The primary purpose of this study is to inform conversations about image retention policy by using PACS audit trails to study the clinically useful life of medical images.

### **METHODS**

The Princess Alexandra Hospital (PAH) is the major tertiary hospital for the southside of Brisbane. PAH uses the AGFA WEB1000 for the enterprise distribution of medical images and reports. To enable events in WEB1000 to be audited, an events database (written in MySQL) was developed and has been collecting data since April, 2004. Three separate extracts are performed continuously for study, event and user details at an interval of 15 minutes.

- Study details are extracted from the Agfa Impax 5.2 database for all verified studies. Study detail recorded includes but is not limited to modality, study description, study date, study time and patient location.
- Event details are extracted from the Agfa Web1000 database for all events recorded of the following types; image viewed, report viewed and report approved. Also recorded is the date/time stamp of the event and the user id who actioned the event.
- User details are extracted to maintain a list of users on the system and their roles. A mapping links patient location to medical specialty

Data from the WEB1000 events database were used to record or calculate a unique identifier for each study, the procedure, the modality, the ward and medical service of the patient, the date and time the study was performed, the date and time the study was viewed and the age of the study when viewed. The recorded data was filtered for information relevant to this study (plain chest imaging, plain orthopaedic imaging and CT scans). The relevant dataset was analysed and further deconstructed and analysed according to modality and medical service.



#### **Time Periods**

Figure 1: Graph of 1st Time Viewed for Chest Plain X-Rays

#### **Orthopaedics (904 cases) - First Time Viewed**



**Time Periods** 

Figure 2: Graph of 1st Time Viewed for Orthopaedic Clinic Plain X-Rays

#### CT (1200 cases) - First Time Viewed

### RESULTS

A sample of data from the events database for studies performed between 1st July 2006 and 31st July 2006 has been extracted for preliminary analysis. The results demonstrate, for a majority of studies and for the three procedural types considered here, viewing frequency is highest in the immediate days following the clinical encounter. After this initial period, the clinical use of the image appears to be associated with patient follow-up (e.g. at surgery and/or outpatient review) and diminishes rapidly thereafter.

Table 1 is a summary of the number of times the images from the various areas have been viewed in the period since their creation to the extraction date (6th march 2009).

Table 2 examines the age of the study when first viewed, for Chest Plain X-rays. The information in Table 2 is displayed graphically in Figure 1. Tables 3 and 4 show the same information for Orthopaedic Clinic Plain X-rays and Computed Tomography respectively and this information is also graphed in Figures 2 and 3 respectively.

#### Table 1: Summary of Image Viewing Statistics

| Modality            | Chest Plain X-Ray | Orthopaedic Plain X-Ray | <b>Computed Tomography</b> |
|---------------------|-------------------|-------------------------|----------------------------|
| Max times viewed    | 26                | 20                      | 59                         |
| Average time viewed | 4.4               | 3.2                     | 5.8                        |
| Median times viewed | 4.0               | 2.0                     | 4                          |

#### Table 2: Chest Plain X-ray

| Chest X-ray<br>Study Age<br>1st Time Viewed | First<br>Day | Day<br>2 to7 | Week<br>2 to 3 | Week<br>4 to 6 | Week<br>7 to 26 | Week<br>27 to 52 | >12<br>Months | Total No of<br>Cases<br>Studied |
|---|--------------|--------------|----------------|----------------|-----------------|------------------|---------------|---------------------------------|
| Number of Cases                             | 1797         | 296          | 91             | 53             | 42              | 18               | 57            | 2354                            |
| Percentage                                  | 76%          | 13%          | 4%             | 2%             | 2%              | 1%               | 2%            | 100%                            |
| Median (days)                               | 0.10         | 2.71         | 12.90          | 30.09          | 68.51           | 302.40           | 505.12        | 1                               |
| Median (weeks)                              | 5-10-1       |              | 1.8            | 4.3            | 9.8             | 43.2             | 72.2          |                                 |
| Median (months)                             |              | X            |                | 1              | 2               | 11               | 18            |                                 |



#### Figure 3: Graph of 1st Time Viewed for Computed Tomography

Initial examination of this data indicates that the variation of image viewing with time demonstrates consistent patterns associated with patient treatment episodes. These patterns may also be correlated with factors including modality type and medical service.

## CONCLUSION

This preliminary study has undertaken a preliminary examination of the variation of image viewing frequency with time for plain chest films, plain orthopaedic films and CT scans. The results indicate that patterns of medical image use by clinicians, hence the clinically useful life of the images, extend beyond just the initial clinical encounter. Further, there appear to be differences in clinically useful life for different modalities and medical services.

This suggests that simplistic approaches to digital image retention that translate policies that were in place for filmbased archives to the digital paradigm may not be appropriate to clinical requirements.

#### **Table 3:** Orthopaedic Clinic Plain X-Ray

| Orthopaedics<br>Study Age<br>1st Time Viewed | First<br>Day | Day<br>2 to7 | Week<br>2 to 3 | Week<br>4 to 6 | Week<br>7 to 26 | Week<br>27 to 52 | >12<br>Months | Total No of<br>Cases<br>Studied |
|--|--------------|--------------|----------------|----------------|-----------------|------------------|---------------|---------------------------------|
| Number of Cases                              | 608          | 58           | 47             | 42             | 59              | 29               | 61            | 904                             |
| Percentage                                   | 67%          | 6%           | 5%             | 5%             | 7%              | 3%               | 7%            | 100%                            |
| Median (days)                                | 0.04         | 2.99         | 10.20          | 28.07          | 65.99           | 321.05           | 506.18        |                                 |
| Median (weeks)                               |              |              | 1.5            | 4.0            | 9.4             | 45.9             | 72.3          |                                 |
| Median (months)                              |              | 11 Mar       |                | 1              | 2               | 11               | 18            |                                 |

#### **Table 4: Computed Tomography**

| CT<br>Study Age<br>1st Time Viewed | First<br>Day | Day<br>2 to7 | Week<br>2 to 3 | Week<br>4 to 6 | Week<br>7 to 26 | Week<br>27 to 52 | >12<br>Months | Total No of<br>Cases<br>Studied |
|------------------------------------|--------------|--------------|----------------|----------------|-----------------|------------------|---------------|---------------------------------|
| Number of Cases                    | 758          | 218          | 118            | 36             | 37              | 10               | 23            | 1200                            |
| Percentage                         | 63%          | 18%          | 10%            | 3%             | 3%              | 1%               | 2%            | 100%                            |
| Median (days)                      | 0.10         | 2.90         | 11.97          | 28.09          | 73.23           | 325.20           | 517.17        |                                 |
| Median (weeks)                     | K. They      | A THE        | 1.7            | 4.0            | 10.5            | 46.5             | 73.9          | II THEN                         |
| Median (months)                    | Part P       | MAN N        | to for         | 1              | 3               | 12               | 18            |                                 |

This study has provided a foundation for further investigation to inform the conversation around retention policy for digitally archived medical images. Further work is planned to take into account a number of additional factors, including:

• The clinical relevance of archived digital images,

70%

Median

- The ease of access by clinicians to digital medical image archives,
- The decreasing unit cost of digital storage media,
- The increasing information management costs for digital image archives,

Extension of this work aims to develop automated processes that can be used to assist PACS administrators to identify images outside of the clinically useful timeframe for culling from archive.

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