Principia Medicinae Digitalis Sotoniensis

Essays on the Evolution of the UHS Clinical Data Estate 1980 -2024

Section 2 Essay 3

The UHS Lifelines Version 2- Version 3 2012-2016

12th Dec 2024

Author David Rew

Publication Plan

The essays which comprise this series will be made available in the first instance on my professional website, https://www.wessexsurgical.co.uk as downloadable PDF documents for review, comment and as a basis for further contributions. They will be amended, updated and supplementary as necessary and as any new material becomes available. All with knowledge and participation in the UHS digital programme are welcome to contribute, by communication with me through dr1@soton.ac.uk.

Once the project is as complete as is achievable with the available contributions, final copies of each of the essays will be submitted to the University of Southampton ePrint server for formal publication.

Copyright

The copyright of this collection is invested in Mr David Anthony Rew as the originator of the project, editor, principal author and compiler of the collection of essays. The content of each essay is made available on a Creative Commons Version 2 CC BY basis, under which Licensees may only copy, distribute, display, perform and make derivative works and remixes based on it on the basis of Full Attribution, including formal Citation where appropriate in books and academic publications. Full acknowledgement is given to all contributors to the written work at appropriate points in the text.

This is the 12th essay in this series, in which I have sought to record the history of the University Hospital Southampton (UHS) Clinical Data Estate (CDE) from the earliest beginnings in the late 1980 to the present time (2024). It is also the third essay in the second section of the collection. This describes the history and development of the UHS Lifelines system from first principles in 2009 to a central role in the UHS CDE and Electronic Patient Record (EPR) in 2024.

Section 2 Essays 2.1- 2.7

Essay 2:1: The Principles of Clinical Data Visualisation

Essay 2:2: UHS Lifelines Version 1 2009-2011

Essay 2:3: UHS Lifelines Version 2-3 2012-2016

Essay 2:4: UHS Lifelines Version 3 2017-2018

Essay 2:5: UHS Lifelines Version 3 2019-2020

Essay 2:6: UHS Lifelines Version 4 2020-2024

Essay 2:7: Reflections and the future of UHS Lifelines

Essay 2.3 describes the development of the second and third versions of Lifelines, from 2012 to 2016. The development of the second version of Lifelines was integral to the history of the Southampton Breast Cancer Data System (SBCDS). This is covered in Section 3, in which the essays are dedicated to SBCDS.

.

Contents

Introduction

In the previous essay, I introduced the development of UHS Lifelines through 2009 to 2011, at which point we had built a credible version of the concept in the test system of the UHS Clinical Data Estate, and had presented it to the Trust.

At this point, work on the original lifelines (Version 1) interface was halted. Alan Hales had sold the intellectual property which was embodied in the work of his company, Scorpio Ltd, to Ascribe Ltd. This sale had included the rights over the various components of the UHS CDE which he had built, including eDocs, eQuest and HICSS. He was very concerned not to breach the contractual terms of the sale, which prevented him from developing parallel products using the code base that he had built and sold to Ascribe. This clearly caused him considerable discomfort

Lifelines Version 2 2012-2014

Our focus therefore shifted at the end of 2011 to the further development of the Southampton Breast Cancer Data System (SBCDS), which originated in 2009 as a specialist database Application within the UHS Hospital Integrated Clinical Support System, HICSS.

The database comprised an HTML enabled page for each and every breast cancer patient for whom treatment records existed in the Hospital, going back to the 1970s. Each page or record contained a series of drop down menus and data entry fields into which information could be entered manually on that pathology and treatment variables, and separately for left and right breasts.

The framework records were created and either manually or automatically pre-populated with demographic data. Alan was able to re-create very large numbers of records from pre-existing data sets on spreadsheets (Essay 3:1).

We soon realised that a newly coded version of Lifelines which automatically displayed within each breast cancer record would make it much easier to populate the data fields, with evidence taken directly from the relevant documents (Figure 1).

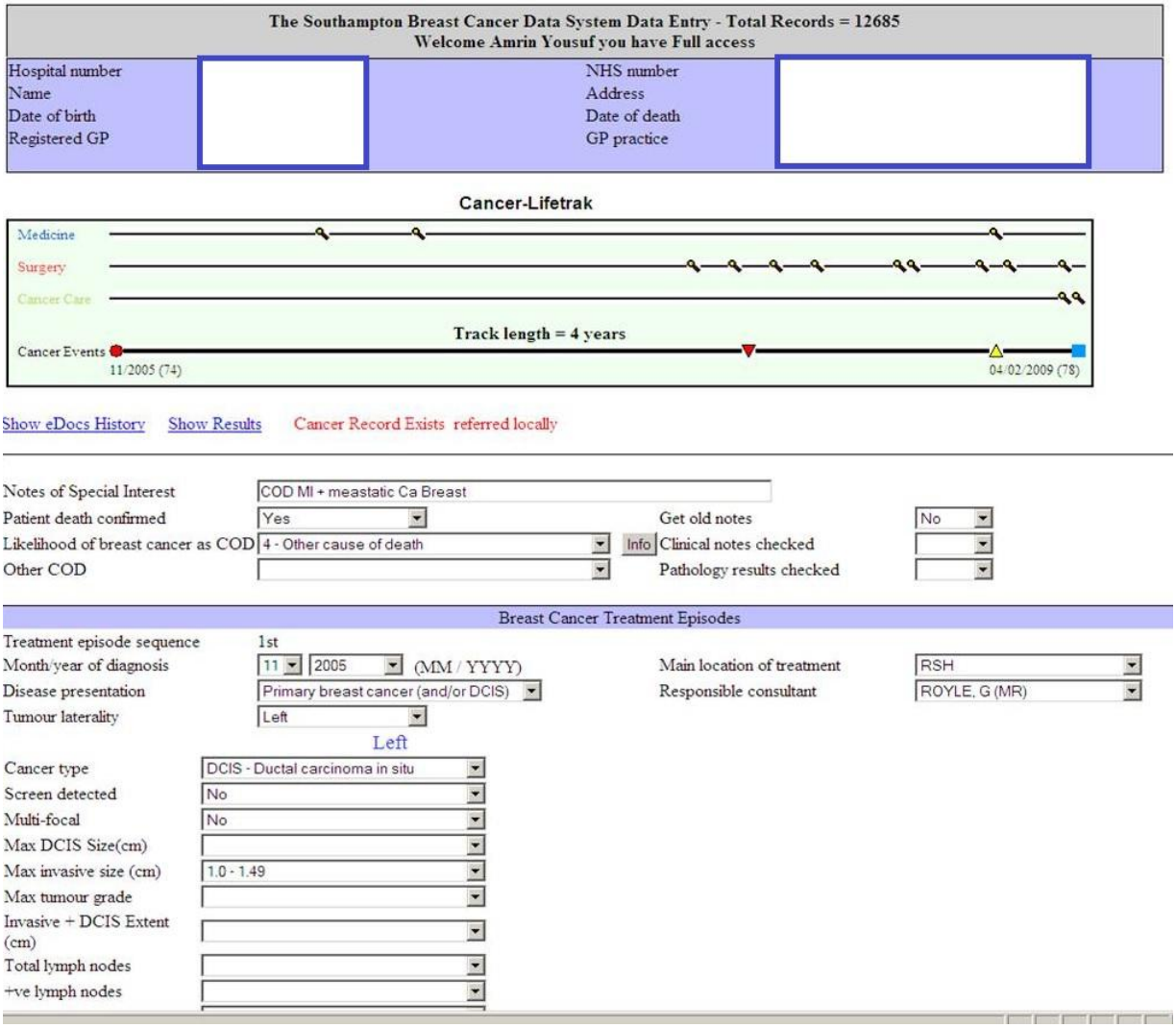


Figure 1. This shows a skeletal early version of UHS Lifelines Version 2 within the breast cancer data system. Each record automatically loaded and integrated the relevant Lifelines display for that patient.

This observation led us progressively to add more clinical timelines to the Lifelines v2 model. It also prompted us in 2014 to backload almost 350,000 archival Trust histopathology records dating back to 1990 into the eQuest data repository, as we have reported in a paper in the Journal of Clinical Pathology (Rew et al 2021).

A significant proportion of these archival histopathology records related to cases of breast neoplasia, so displaying these on a histopathology timeline in Lifelines version 2 led to a rapid and very efficient enrichment of many breast case records. This work is described in much greater detail in Section 3 of this essay collection.

The re-development of Lifelines version 3 from late 2014 onwards.

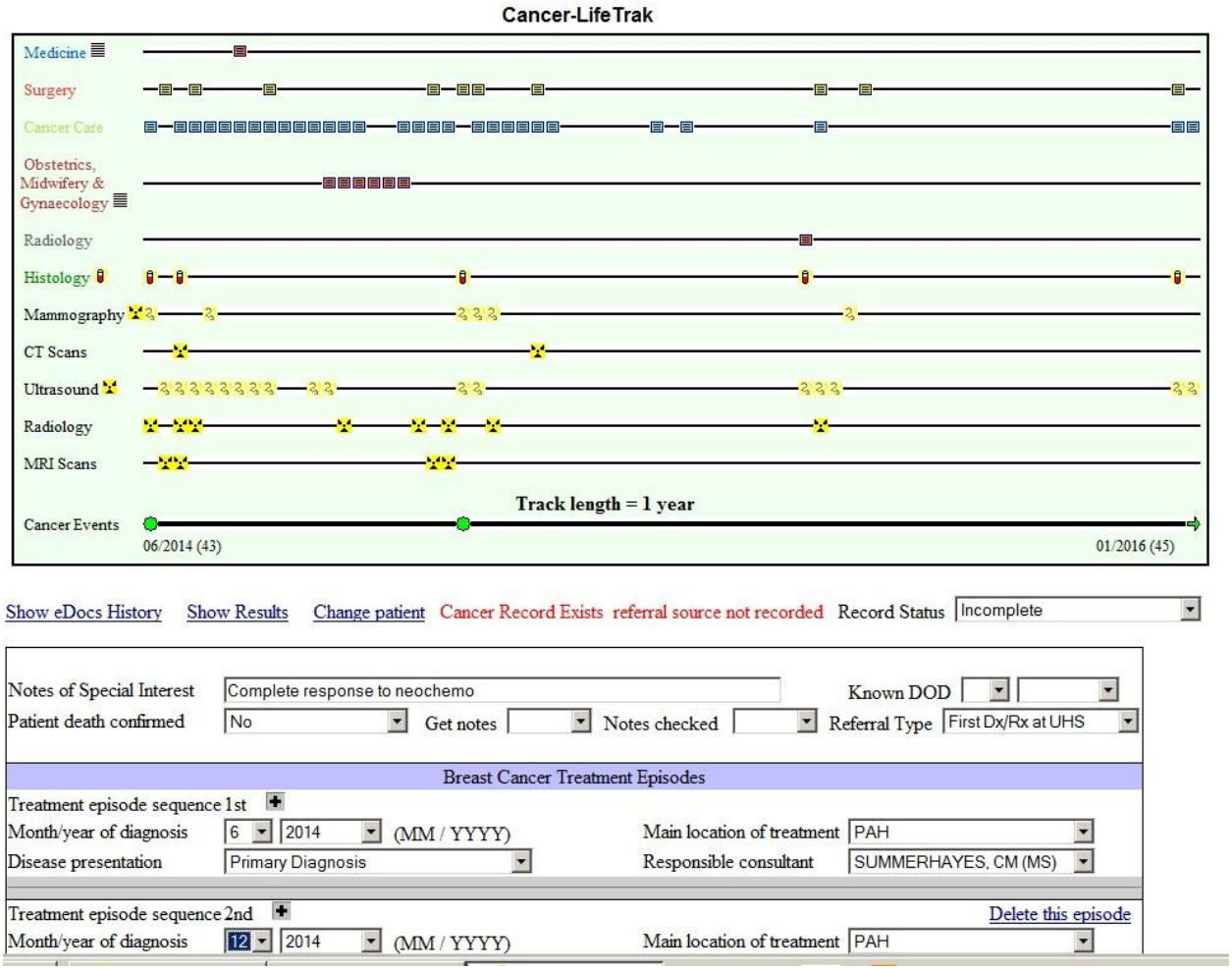


Figure 2. Lifelines version 3 within the Breast Cancer Data System

The work done on Lifelines Version 2 and the proof of its utility within SBCDS had persuaded us of the merits of Lifelines as a valuable tool for the primary Trust EPR interface. We continued to expand the range of clinical subject-specific timelines from eDocs, moving to the point where all eDocs content was displayed in Lifelines.

By late 2014, there were several drivers to re-write Lifelines version 3 in DotNet. The ASP.net code with SBCDS was likely to be difficult to develop further, given the unfamiliarity of junior coding teams with ASP, and the model was constrained within the SBCDS code base. We were also challenged by general changes in the software environment, which was secured within a Microsoft Active Directory Enterprise security system.

This Application was delivered via a Trust-Wide TCP/IP network that was also connected with the NHS National Network (N3). The standard UHS desktop was a Windows PC running an Internet Explorer (IE) graphical web browser. Microsoft was in the process of retiring IE in favour of the new MS Edge browser framework.

Therefore, from late 2014 through to 2016, Alan Hales rewrote the SBCDS-specific version of Lifelines in more modern (MS Dot.NET) code, as this would be more familiar to the next generation of developers and it would help to ensure the legacy of Lifelines.

On 13th November 2014, Alan reported that: *"I am working on Lifelines v3 and have an initial prototype up and running... It involves a lot of complex coding even if the end product looks rather simple. I cannot re-enable the code for the original 2009-2010 lifelines model for reasons of my previous contract with Ascribe".*

The Adaptation of Lifelines Version 3 as a generic UHS interface for all patients

The content expansion strategy within Lifelines made SBCDS increasingly attractive as the primary interface for all clinical activity in the Breast and Endocrine service, including non-cancer cases. I used it continuously in support of my outpatient activity, operating lists and during multidisciplinary team meetings.

Key visual changes between Versions 2 and 3were:

- The microscope icon graphics were replaced with a richer palette of icon formats, including greater use of colour and representative shapes (Figure 3).
- The Radiology timeline was subdivided by the type of imaging, for example mammograms, CT and ultrasound scan reports.
- The Cancer Episodes master timeline was further developed and synchronised with all other content in Lifelines.

The utility of Lifelines Version 3 as a primary EPR interface became so obvious in my clinical practice that I was able to persuade Alan and David Cable of the value of placing a reformatted version in front of the Breast Cancer Data System, so that I could use it as a test system for all patients in my clinical practice.

However, at this point, Lifelines could still only be accessed through the SBCDS link, so the existence this "independent", non-breast-specific function of Lifelines version 3 would not be apparent to any non-breast clinician using the Trust EPR.

On 11th March 2015, I suggested to Alan that the new version of Lifelines had the potential to develop as the primary EDMS /paperlight / EPR interface for all UHS documents and data. We also still needed to find a solution to the high density document generation and display.

Alan reported on 3rd April 2015, that he was "*still working on the Lifelines re-development. The approach I was employing proved to be too complex and I've had to go back to the drawing board. I am wrestling with the technical challenge of gathering the various data from the system and organising it for graphing in a way that then allows the data to be re-accessed when zooming in/out of the date range. The original code was horrendously complex as a result of my incremental development and of technical functions that are no longer supported.*

Development of version 3 of Lifelines continued. By 7th September 2015, I was able to inform Christine McGrath (Trust R and D director), to Jane Hayward, Director of Transformation, and to Derek Sandeman, Trust Medical Director of the developments with Lifelines, and to observe that:

"We consider that the system has the potential substantially to improve the productivity of all members of staff who are now using electronic documentation. It should thus yield many millions of pounds of productivity savings on a recurring annual basis in the near future. The development also raises the question as to how much we really need an additional EDMS, given the power and the further development potential of UHS Lifelines.

Concurrently, I noted for Alan that:

T*he new version of Lifelines works just as we had hoped, and the user can link directly and quickly into eQuest and eDocs from the interface. It has substantially accelerated my outpatient clinics, as intended... we now have a tool which is an advance over paper records files in terms of its logical and intuitive structure. Another gain is that it is simply much faster*

to open new cases than are the EMIS products, even before the substantial reduction in clicking is vectored in.

Lifelines also caused interest around PAH to a number of observers, including our Breast MDT Lead and our Breast Service Manager, who grasped the concept immediately and intuitively without the need for any training. Our Outpatient Lead for Surgical Pre-assessment asked us specifically to add the Cardiothoracic timeline, as her team has a recurring need to check on a patient's Cardiac Status.

I also asked Alan give some thought to a version of Lifelines which would be identical to the new version of Lifelines within SBCDS; be scrollable using a horizontal slider back to 1990, and probably displaying no more than two years of records at any one time; and which - would contain all clinical, radiology and pathology lifelines.

The Challenge of Document Overload on Clinical Timelines

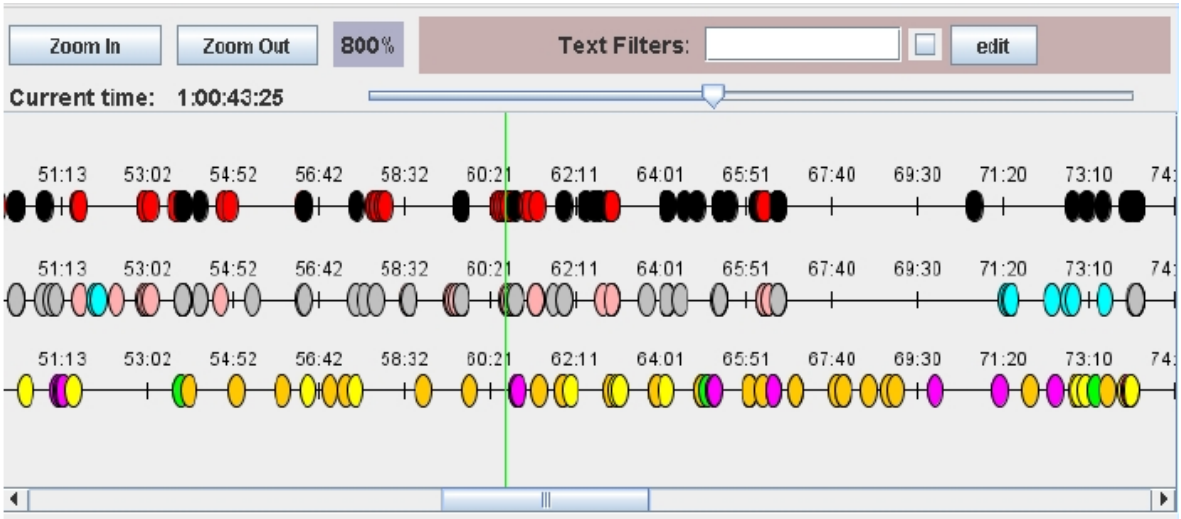


Figure 3. This image highlights the problem of icon occultation owing to information overload in a timeline.

In Version 1 of Lifelines, we had first met the problem of document overlaod to a minor degree. This had been addressed by overlapping icons which coincided at any one time point. Figure 3 highlights this problem with greater clarity than does our own original imagery. This illustration is taken from the final report of the MITRE-Sponsored Research

(MSR) project “Applying User Models to Improve Team Decision Making”, Project 51MSR120 (FY2004 and FY2005) and 05MSR107 (FY2006) by Bradley Goodman and colleagues. It shows very clearly how increasing document overload at any time point on any timeline causes increasing occultation of the underlying documents as the number of documents or events increases.

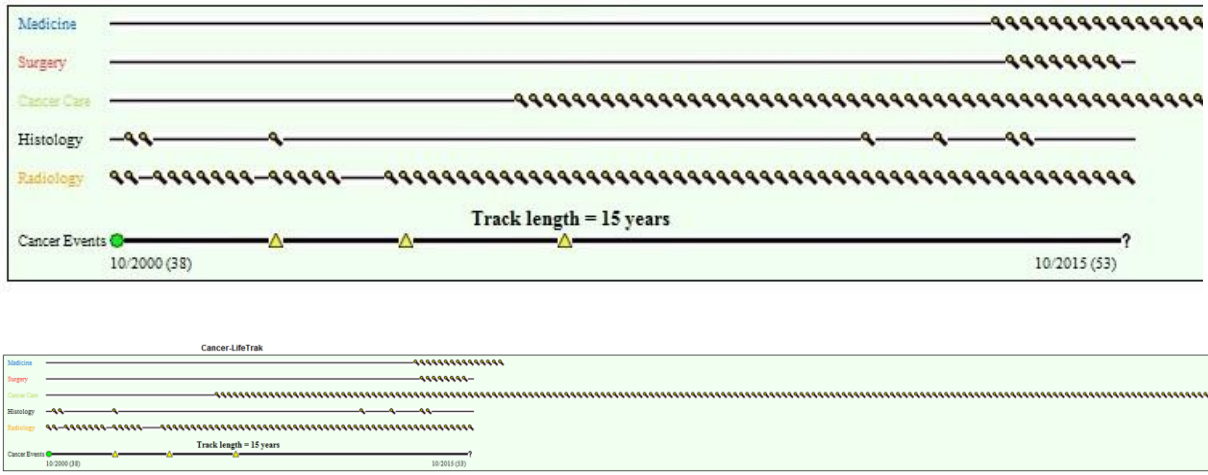


Figure 4: Timeline overload in UHS Lifelines Version 2, 2015. The lower image is of the same screenshot, showing the full extent of the overload.

Lifelines Version 2 also provided a very valuable learning platform around the rapid and unstructured digitisation of documents in the Trust. An instruction went out from the hospital management team that all cancer nurse contacts with patients, including telephone calls, should each be recorded on a separate e-document, whereas previously they had been collated in diaries or on hand-written index record cards. T

he intent of this new method of auditing cancer nurse specialist workload was laudable, but the direct consequence was an explosion in cancer care documents.

We had previously sought a workaround to the problem of document overlap on timelines by loading the individual 12 x 12 pixel icons side by side on the relevant timeline. This model now created massive right shift displacement of icons from their true position on the timeline. The extreme exemplar in Figure 3 highlights the problem.

By 8th September 2015, a practical solution was needed within Lifelines to the overload problem, as we had no control over the document creation process. Alan observed that *"the visualisation problems are frequently a result of poor past hospital practices... This example provides an ideal opportunity to demonstrate the importance of clearly thought out document scanning, uploading, labelling and tagging".*

I alerted David Cable and Adrian Byrne to the issue, noting on 5th October 2015 that: *"The phenomenon of catastrophic document overload on timelines ... is of fundamental significance to the design, build and purchase specifications of any future EDMS."*

The mock-up demonstration screens for OnBase 2016 which have been produced by Hyland and other commercial providers who have not tested their systems in massively cluttered data environments such as we are now creating, will lead us into real difficulties if we do not now challenge the suppliers for solutions.

The Flip-book exemplar as a solution to document overloading

One possible solution would be to use a Flipp-DF type system, such as is commonly used for commercial publications (Figure 5), whereby we would recreate virtual notes folders which users could flip through with ease. This technical fix would recreate the utility of paper folders but with added digital functionality, such as hyperlinks within documents.

Figure 5. The "flip-book exemplar: software tools will readily convert series of PDF documents into facsimiles of magazines on screen for conventional reading

Southampton Solent University Students and the solution to Document Overload

A conceptual stimulus to the solution to document overload came in the form of Alex Potter's undergraduate project at Southampton Solent University. For three academic years from 2014, Alan and I had co-supervised 5-6 undergraduate projects per annum in three final year cohorts of the Solent Computer Sciences Curriculum.

The programme was originally set up in early 2014 when I approached Dr Al Monger, who was then the Academic Leader for External Development of the Technology School of the Faculty of Maritime and Technology at Southampton Solent University. His colleague Dr Jing Lu took on the supervision role with great enthusiasm and energy.

Our intent for the programme was to give undergraduate students in the computing science streams the opportunity to experience and challenges of programming in healthcare environments. It was remarkably successful in the first year (2014-2015), with students scoring high marks in studies in data mining of anonymised SBCDS data.

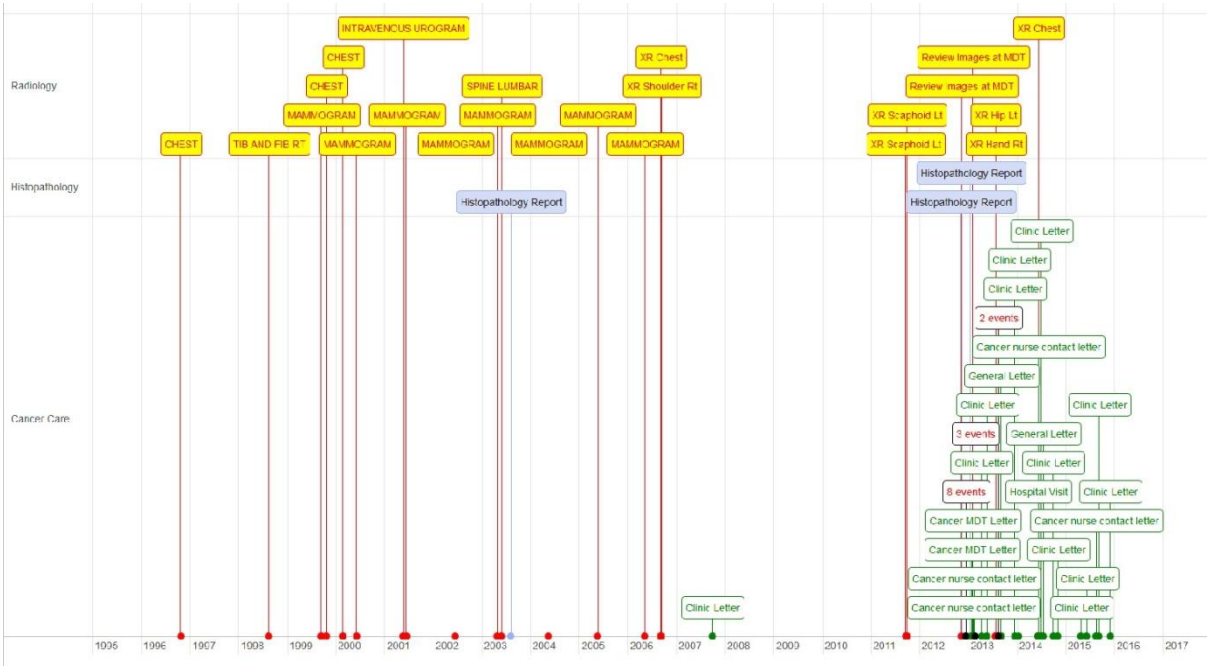


Figure 6: A screenshot from Alex Potter's project of the use of balloons to convey metadata on documents on an overloaded timeline. Where documents overlap, the metadata balloons are combined on a single stalk. (Figure courtesy of Alex Potter).

In the second year of the programme (2015-2016), student Alex Potter undertook a project in which he focussed on data clustering and labelling of timeline data points (Figure 6).

On 20th March 2016, Alan wrote to say that *"Alex Potter's timeline clustering project work is very good, but it needs a lot of work to evolve it into something fit for clinical use. It is dependent upon real-time access to Google cloud services, which is not a viable way forward as any external internet interruption would bring the application to its knees."*

The key to the solution was Alex' recognition that is was possible to relate multiple documents or events to a single point on a timeline using metadata balloons. Alan was prompted to recognise that by using a single icon to represent multiple documents or events which coincided or were "clustered" around a single time point on any given timeline, far more information could be incorporated on the interface (Figure 7).

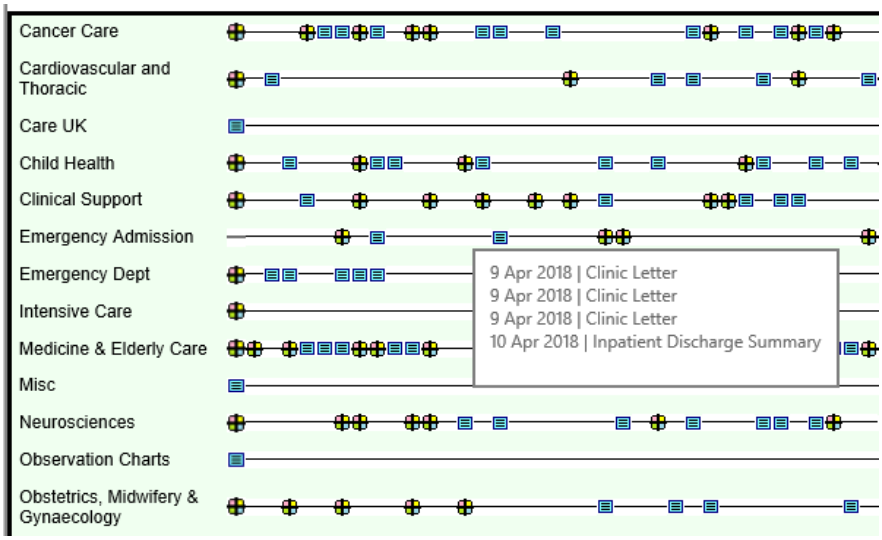


Figure 7: This figure illustrates Alan Hales' definitive solution to the overlap conundrum. An individual icon represents multiple events. Hovering over the multiview icon (the cruciate or "hot cross bun" design) displays all of the metadata in the documents and events at that time point. Clicking on the individual document titles opens the individual document in full in a separate frame. As shown in Figure 8..

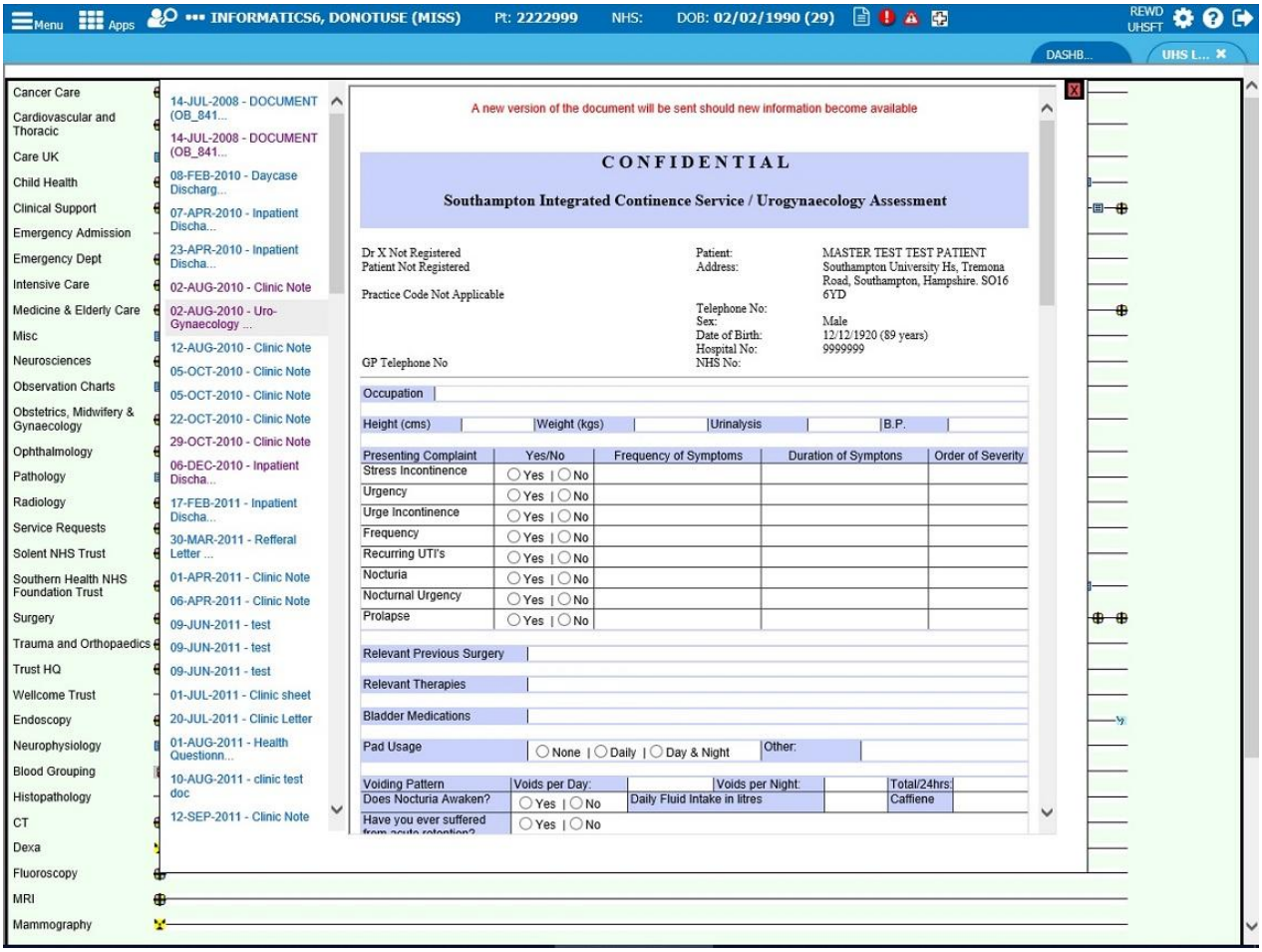


Figure 8: An open document in the hybrid multi-view icon in our test system. The other documents in the multi-view are listed within the frame in date order and can be opened directly by clicking on the name tabs.

Consideration of Lifelines as the primary interface for the EDMS Project

From 2013 onwards, discussions progressed around the acquisition an Electronic Document Management System (EDMS) (Essay 1:9). This led to the contract with Hyland Software of Cleveland Ohio for acquisition of the OnBase v16 EDMS for the UHS Electronic Patient Record (EPR). The initial expectation was that the existing UHS EPR would become subservient to OnBase by late 2017, as OnBase was fully integrated into UHS workflows.

Nevertheless, we strongly believed that in Lifelines we had created a superior system to the early interfaces in OnBase v16, and indeed I worked hard but unsuccessfully to persuade the Hyland team of the merits of developing a Lifelines-like interface to the OnBase.

As the limitations of OnBase 16 became apparent in clinical use, it became evident that the that the locally developed CHARTS system would continue to act as the Trust's primary EPR, thus also throwing Lifelines a lifeline.

In September 2015, I updated Adrian Byrne, the Trust's Chief Information Officer and Jane Hayward on the excellent progress with the project to develop Version 3 of Lifelines, vis:
"Alan has done a fantastic bit of programming over the past few days to resurrect the original lifelines tool, as a bolt on front page to the innovative Breast Cancer Data System. The potential importance for UHS economics cannot be understated...". A truly efficient clinical interface might restore millions of pounds worth of clinical productivity to the Trust's financial bottom line.

... The (Onbase) EDMS strategy is significantly and expensively slowing down clinics in consequence of the time taken to sift through, open, read and remember the electronic content... "Lifelines" addresses this problem at source, by giving an immediate, logical and temporal structure to electronic documents in ways which improve upon the paper record. It would be helpful ... if a modest investment were made to extend SBCDS to all cancers treated in the Trust...".

Adrian replied that:
"I am aware of the work that you have done with Alan with the Lifelines project, and I have had a recent demo of it. I am impressed with the layout and the speed of it. It is however prototype software and built as such there would be concerns about roll out of it "as is". We aim to have the Hyland OnBase EDMS stood up come February 2016. This is a product will not feature bespoke UHS elements, and it will not hook into all of our data sources by default. It will probably appear as quite a vanilla presentation in comparison to the detailed work that you have carried out with Alan...

In terms of decision making, I do not think this is the right point to be doing any of that... Should we decide to invest in the Lifelines project we need to bear in mind that:

- Lifelines is not currently an "Enterprise Hardened" piece of software. As such it is fine for use as intended for yourself and people who understand its possible shortcomings and lack of resilience.

- If we were to make this a strategic platform, then it would require investment and around 12 months of effort from a full time developer, and for technical project management

- It is not clear how we would embed it into Doctors' Worklist and the EDM.

- It is possible that we could transfer the intellectual property and enhance those products. However, software companies do not like highly tailored solutions, as they cannot sell them

- The usual route to deployment, includes the ISSG and clinical safety sign off

- I suggest a review of where we are. I have spoken to Jane Hayward, Derek Waller, and Mark Griffiths about this. An initial meeting where you could present your hypothesis, plus some discussion would be very helpful".

I thanked Adrian for this encouraging response, noting that: *"We are already aware of a number of technical and conceptual challenges, opportunities and constraints which will need to be addressed in further iterations of the system if it to become bomb-proof. However, these issues apply similarly to any of the commercial solutions, where they are likely to need resolution at far greater cost than our in house solutions. ...*

Alan added that

"I am pleased to see that this topic is now receiving wider management consideration at UHS in a way that has the potential for a much better route forward. I've mentioned and shown Adrian and David Cable examples of PDF-mania which they quickly acknowledged. It is their belief that current behaviour is not a result of management directives, but more a lack of them. This is fertile material for clinical debate!"

Intellectual Property and UHS Software

In the course of this conversation, we also touched upon the issue of Intellectual Property protection for Lifelines. I had learned that it may be is possible to protect the Trust's intellectual interest with a European Industrial Design Licence in this system while we test it thoroughly.

Adrian was very supportive of further development of UHS Lifelines. He commented that *"I am relaxed about further prototype development if that would prove more than you already have done. The investment in time has been worth it, but re-engineering may be required at some point.*

Intellectual property (for software) is an absolute minefield. In this case I am not sure what the IP is and therein lies the tale about how difficult any kind of protection would be to obtain:

- Timelines themselves as a patient record presentation are not new

- Timeline presentation broken down into casenote categories such as letters, results, appointments are not new

- Web based portal presentations are not new

- The look and feel of anything is extremely difficult to protect

If there are techniques that have been used that are novel and innovative then these are easier to protect but I am not aware of any in this case other than the bespoke nature of interfaces, which of course could not be replicated anyway. In actual fact, the reason any software is not routinely copied is more down to just how difficult it is to do properly.

Alan observed that: *"the door is now open to persuade the Trust of the huge value of the concepts which we have espoused; and to a systematic study of the benefits, including the quantitative usability studies which we have discussed....*

The challenge is massive for those of us who have to work through the consequences of these decisions on a daily basis and who seek to maintain a safe and efficient service in a bleak landscape of poorly designed end-user interfaces and systems. Without our work on Lifelines, we would not now be in a position to describe the problems with the present paperlight strategy.

A Conversation with the IT Team at Hampshire County Council

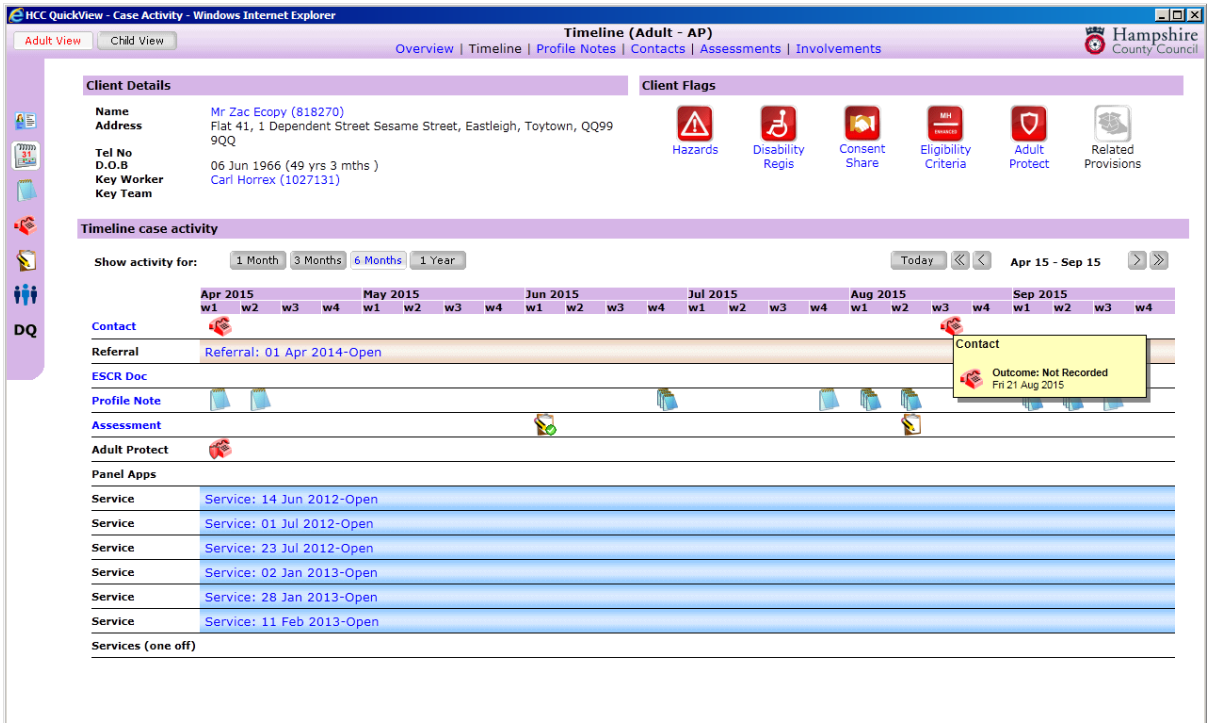


Figure 9: The interface to the Hampshire CC Swift social care records interface in 2015

In the course of various discussions during 2015 about linking Lifelines to social care data, I was introduced to Joe Stephney, who at the time was an IT Technical Consultant to the Council. Joe and his colleagues had independently come to a similar visualisation solution for documentation relating to their social care clients.

On 23rd September 2015, Joe sent me copies of the timeline view (Figure 9) on the home grown Hampshire County Council solution that sat at that time over their social care systems (SWIFT - AIS/ICS). He noted that:

"Although not as detailed as your timelines, it does have some icon ideas (see the profile notes line where a single leaf denotes one and multi-leaf denotes more than one) and buttons for time periods across the top.

HCC are happy to share this but would want to be consulted in advance of ideas being used. I'm sure they would also be happy to be involved with any discussions.

The tool used has been in place for a number of years now and has equally been adopted and endorsed fully by the staff using it (similar to your experiences).

"..all the 'event' icons have hover text which give a summary and they can be clicked on to

look at the detail behind the event. What people see is also role based and linked to the security in Swift."

Regrettably, Hampshire CC subsequently replaced SWIFT with a newer system, and Joe moved on to another job, so we did not have an opportunity to dig deeper into the synergies between our two systems.

THE CONTINUED DEVELOPMENT OF LIFELINES V3 INTO 2016

Cytopathology record display in Lifelines V3

We continued with the development and enrichment of Version 3 of Lifelines through early 2016. We discussed the value of populating the pathology timeline with cytopathology reports. Cytopathology samples are generated from fine needle aspirations or from smears of tissues onto glass slides, in formats which allow them to be analysed by specialist pathologists. In my own specialist fields of breast and thyroid surgery at that time, cell analysis is an important element in a range of diagnoses, as in many other disciplines.

On 11th January 2016, I noted for Alan that: *"As yet, the cyto-pathology reports (fine needle aspirates, cellular smears) are not displayed on any of the timelines on the UHS-Lifeline EPR, although they do appear in eQuest. I wonder whether it would be possible to set this up.*

There may be a large number of reports, given the range of services which use this as a diagnostic technique, including the breast and endocrine services. As with the histopathology reports, it is possible that there are both "current" reports from 2004 onwards, and historic reports in earlier formats - hence my reason for copying this to Keith Burrill (Pathology Laboratory Manager), who may be able to make some suggestions."

Keith observed that *"We are now talking about "Non Gynae Cytology". The UHS lab no longer processes Cervical Cytology. You can access what is currently on eQuest – though I'd like to validate a few sample extractions with our lab system. The reporting format for Non Gynae Cytology changed a few years ago so there may be with formatting that may affect extractions from eQuest.*

The historic records on Labcentre are not currently displayed on eQuest. They may be extractable but there may then need to be a translation decode. I don't believe that the "pre-historic" (ie pre-1997) records were preserved from previous Ferranti lab system".

We also wondered whether we could and should retrieve historic histopathology records from prior to 1990. However, these were all stored on microfiche film and it would have taken a substantial effort to convert then to digital formats. Moreover, the reporting standards for histopathology prior to 1990 were generally much more lax than today, so it was questionable how much added value to our other records such an exercise would bring. We did not pursue the idea further.

Paediatrics and Child Health Timelines on Lifelines v3

In April 2016, Alan added the Paediatric and Child Health timeline to Lifelines, noting that I was seeing a number of under 18 year olds in various clinics. Also, a number of paediatricians were active on the EDMS transition working group, and it would be very helpful to be able to show them the utility of Lifelines.

Lifelines integration into the mainstream Trust EPR

In early April 2016, I suggested to Alan that we might offer a new test interface for the non-breast service clinicians, vis "UHS Lifelines Development EPR" (or similar).

Alan and David Cable agreed with the thrust of the ideas. The challenge would be to create something that could be deployed in a generalised way without having to expend too much effort. Alan felt that it would be ideal if that something can be developed as a "plug-in" that can be incorporated into key EPR applications such as eDocs so that clinicians could choose to look at the EPR history in a timeline format rather than via lists.

He noted that:

"A generalised timeline tool can be deployed with an introductory statement along the lines you have described. If the interface is popular with a significant number of clinicians it should translate into support from Trust management to deliver an operational system and it should help convince the EDMS supplier to embrace the concept within their products.David

and I are currently looking at getting a capable programmer who could work under my direction to take this forward ... efficiently and to the required standard."

General Practice Information Linkage and the Hampshire Health Record:

In April 2016, Derek Waller announced that:

"The second major General Practice Information Technology system, from the Phoenix Partnership (Leeds) Ltd, TPP SystemOne, is now sending information into the Hampshire Health Record (HHR) for Southampton General Practices. There is 90% coverage of GP data for patients in Southampton, which will soon be extended to the rest of Hampshire. The data include diagnoses, allergies, medications, blood pressures (under health promotion), care plans and GP initiated test results.

HHR also holds community care, discharge letters from other hospitals (including the Southampton Treatment Centre), pathology from Portsmouth, some social care and other information. Although Hampshire Hospitals Foundation Trust (HHFT) (Winchester and Basingstoke Hospitals) does not yet put blood test results into HHR, they can often be found in the GP record, thus removing the need for duplicate testing."

Derek followed up a month later to note that:

HHR now contains Social Care information from Hampshire County Council (HCC) in patients' records. This includes the social care team(s) involved with the client; assessments of need; and the type(s) and frequency of care being delivered by social services. To date, there are some 17,000 social care records from HCC in HHR, which are updated daily. The HHR team are working to extend this functionality to Portsmouth and Southampton unitary authorities as soon as possible".

This was an important first step to our long term ambition to integrate GP records into the Lifelines interface. The HHS was subsequently, renamed as the CHIE, the (Hampshire) **Care and Health Information Exchange**, which has since been integrated into CHARTS. However, full integration of CHIE data into Lifelines still remains elusive as of 2024.

The Launch of Lifelines Version 3 as an independent application within CHARTS, 2016

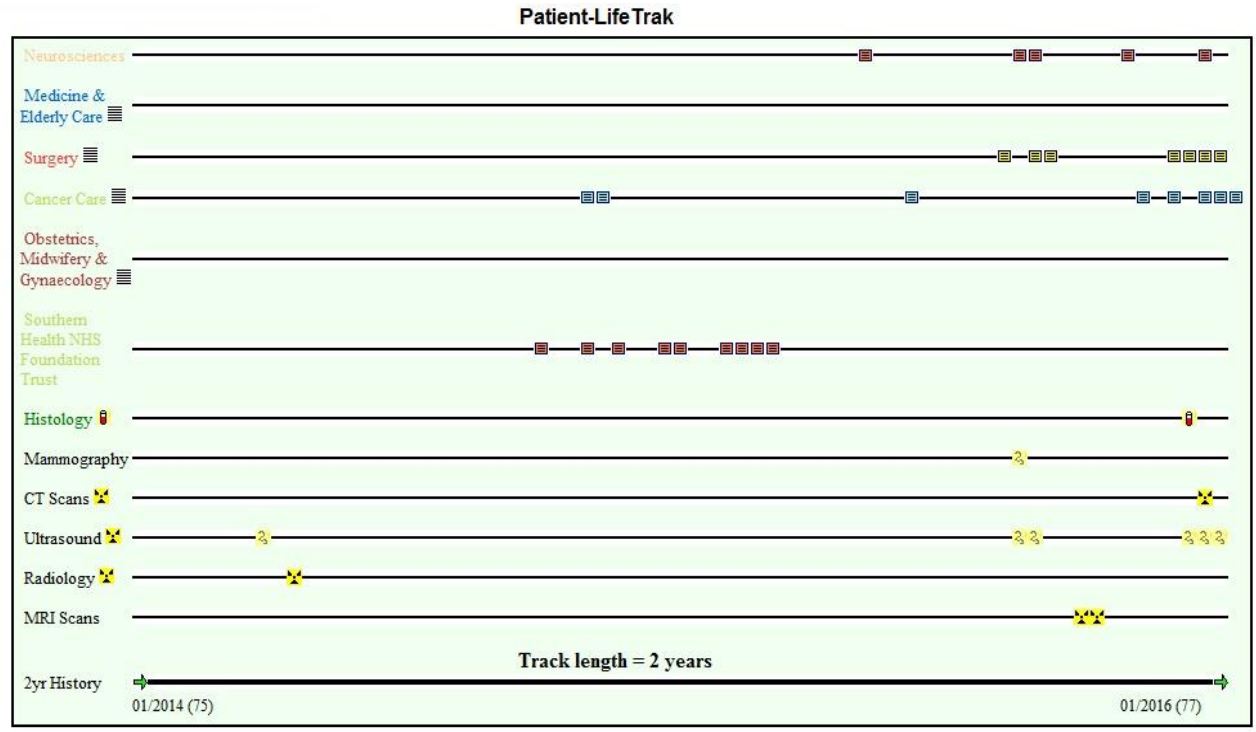


Figure 10. The evolved version of UHS Lifelines Version 2 (ASP code) within the Breast Cancer Data System wrapper, as of January 2016

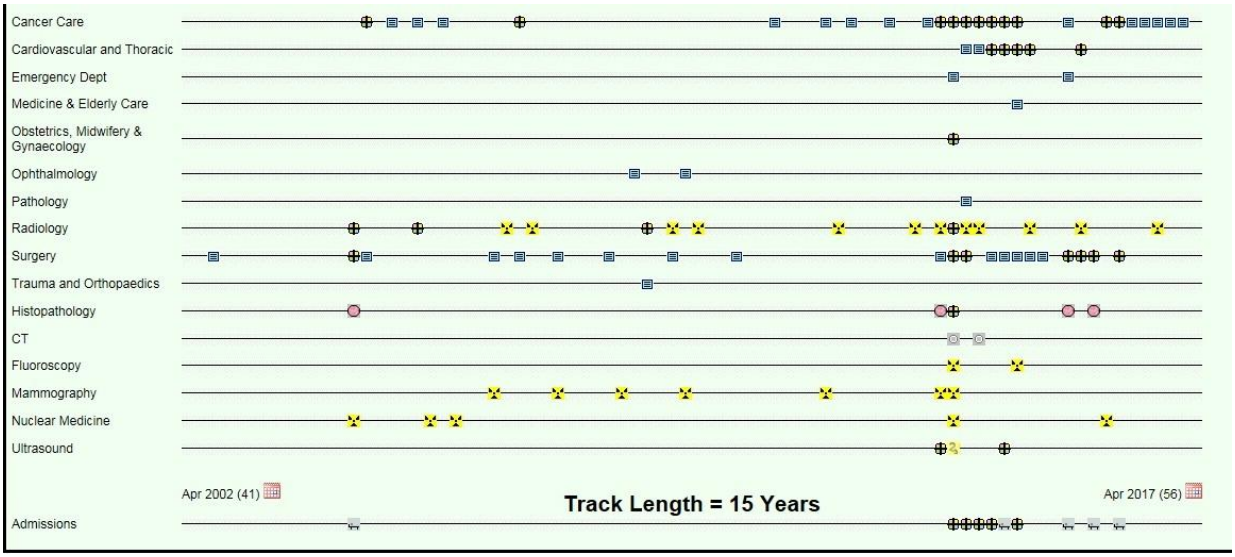


Figure 11. The rewritten UHS Lifelines Version 3 within CHARTS as of early 2017.

We had preserved the visual design features of Version 2, but had reintroduced the Inpatient Admissions timeline with dynamic icons relating to inpatient admissions; a calendar reset function to adjust the timeline view: the multiview icon; and modifications to the iconography.

Towards the end of April 2016, we were in a position to launch Lifelines Version 3 independently of the Breast Cancer Data System for open use across the Trust by placing it within the new CHARTS EPR wrapper.

On 24th April, I wrote to Alan that: *"I am delighted to see that we are at last in a position to realise the grand vision for the UHS Lifelines EPR, from its original iteration in 2010, in a wholly re-written and updated form as a generic API with a range of new design features... With the Hyland EDMS near to implementation, I think it critical that we get UHS Lifelines up and running in its new form asap, accepting that it will iterate and increase in functionality and interoperability with time. (I hope that) word will rapidly spread as to its usefulness once it is in daily use.*

On 26th April 2016, David Cable forwarded *"the user story that I have drafted for EMIS Health (as the owners of the CHARTS software) for the integration of UHS Lifelines with UHS EPR. The aim of the story is not to be prescriptive, in that I don't need to tell EMIS exactly how to write the code, I just need to set out our aims. This same template was used successfully for integration of the 'My Medical Record' in our last release so I know it works... There may be further enhancements that we could specify, but all developments have to compete for a share of development time. What I've set out should make a significant step forwards in terms of integration of UHS Lifelines with core hospital systems.*

The Application to support a UHS Lifelines link from EPR clinical applications

Author: David Cable, Deputy Head of EPR & Programme Delivery, UHS

The User Story: As a health professional I want to be able to access *UHS Lifelines* from the EMIS Health EPR clinical applications so that I can quickly review the patient's historic clinical contacts UHS. This user story is based upon a similar story developed for the integration of EMIS EPR with My Medical Record.

Acceptance criteria

- Access to *UHS Lifelines* is to be controlled

- The *UHS Lifelines* icon displayed on patient demographics screen and patient ribbon within all applications for all patients.
- *UHS Lifelines* is to appear as a "*Jump to"* option within CHARTS
- A "Tooltip" on the icons will provide further information to users. These tooltips should be configurable within the database to allow for UHS to update them.
- Clicking the *UHS Lifelines* icon will launch a UHS web service that will check user credentials and open the UHS Lifelines application. Web service details to be provided by UHS. The Patient number and user ID will be passed across for security and audit.
- The Window must be closed to return focus to EPR application.
- The integration of EMIS EPR and *UHS Lifelines* must be robust and developed in such a way that future changes to EMIS EPR take into account the UHS Lifelines application and maintain data integrity and system accessibility.
- UHS should be able to change the URL of LifeLines independently of EMIS

Exclusions

- Audit trail functionality of use of the system will be maintained within UHS Lifelines.

- *UHS Lifetrak* is a tool within the *UHS Lifelines* framework which allows description of the patient care pathway from diagnosis to final outcome on a user defined, episode structured basis. *UHS Lifetrak* is a derivative component of *UHS Lifelines*. It is a master or narrative timeline which runs in parallel with the subject specific lifelines. *UHS LifeTrak* allows the course of a chronic disease to be visualised from onset, through user defined phases or episodes, to final outcome.

UHS Lifetrak is currently in use with a breast cancer patient cohort and evaluation is underway to determine whether it has useful applications for other disease types.

Full integration with EMIS EPR will be subject to a further user story.

The Anticipated Benefits

- UHS Lifelines will allow users to view critical patient 'data' in a structured chronological format, which will speed up the clinical decision making processes.

Supporting information

Ownership: The *UHS Lifelines* application is the property of University Hospitals NHS Foundation Trust. Requests to use the UHS Lifelines system outside of the scope of this document should be forwarded to David Cable.

Relationship: UHS EPR teams will work with EMIS team for the interface configuration of the on UHS Lifelines application.

Access: Proposed UHS Lifelines access control mechanism are based upon EMIS EPR setup:

- EMIS application permissions are checked for the logged-in user.
- If the user has eDocs and eQuest/Results Server they can see everything.
- If the user has only eDocs access they see only content originating in eDocs (or uploaded/attached with eDocs)
- Users who only have eQuest access will only see content from the eQuest/Results Server.
- For the cancer Lifetrak to be displayed, the user must have access to SBDCS.

Technical: We suggested various methods for calling *UHS Lifelines* from other applications:

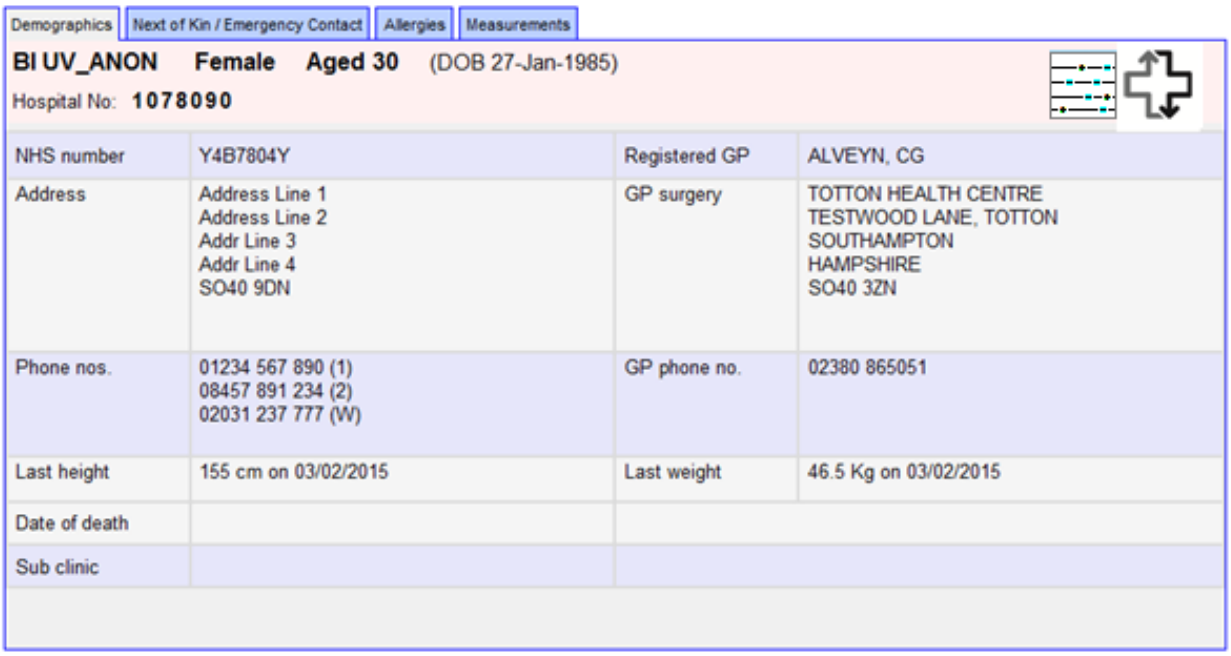


Figure 12. The proposed UHS Lifelines icon on the Demographics interface in CHARTS

The proposal is that the *UHS Lifelines* icon appears on the Patient's Demographics tab when a patient search is conducted.

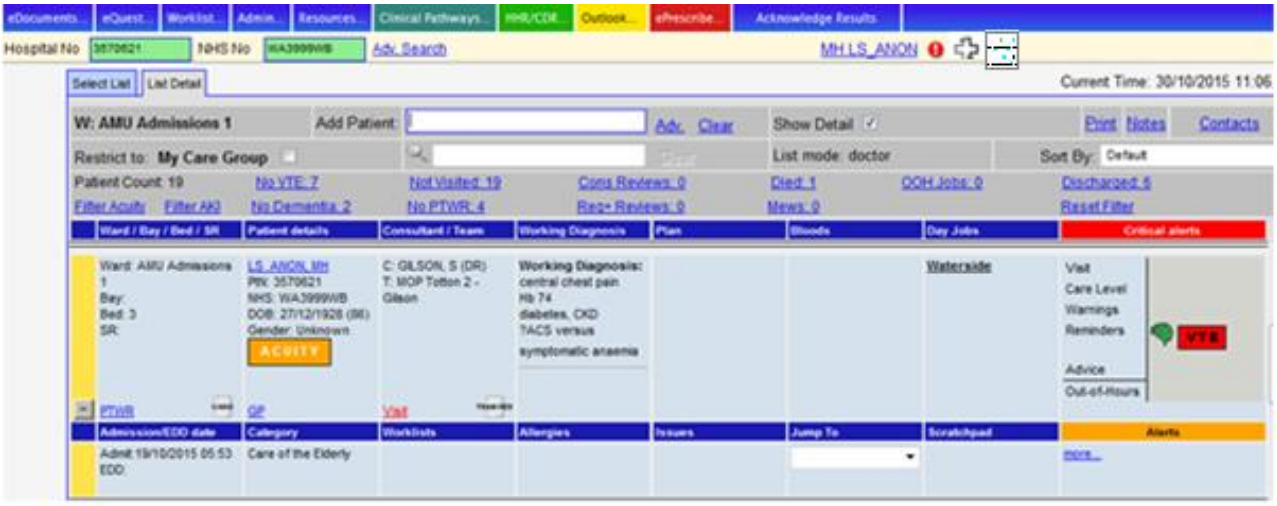
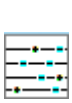


Figure 13: The proposed UHS Lifelines view link Doctors/Nurses Work Lists of CHARTS (top right of screen).

Figure 14. The proposed clickable icon for UHS Lifelines in eDocs

Figure 15. The proposed UHS Lifelines link on HICSS Surgical Ops or any other HICSS Module




The design for the Lifelines and My Medical Record icons:,Their proposed locations are shown in the mockup screenshots in Figures 12-16

Figure 16. The proposed position of the UHS Lifelines link on eQuest, including in Result Server, View Request and Place Request.

I noted that it would be important at some point to obtain some hard data on how speeds of access to documents and reports vary with the various interface formats.

The implementation of the dynamic link eventually took the form of an application tile within the new CHARTS interface, as illustrated in Figure 17.

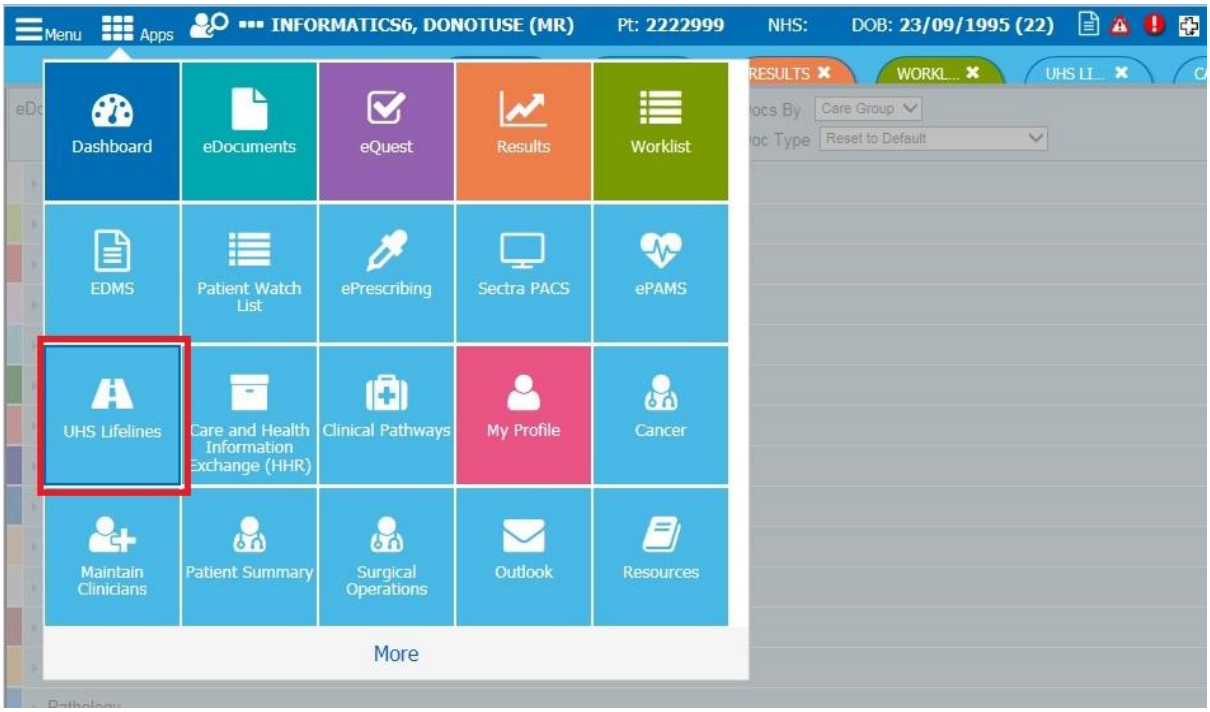


Figure 17: Screenshot of the CHARTS interface in 2017, demonstrating the incorporation of UHS Lifelines as an application within the system (highlighted in red)

Preparations for the Trust-wide release of Lifelines Version 3

Pending the formal release of Lifelines v3 in September 2016, we considered further refinements and detailing to the new version. Alan and I discussed:

- How best to reinstate the “Admissions” timelines which had been a valuable feature of the original Lifelines v1, noting that the admission (inpatient and outpatient) data that was displayed in the original Lifelines prototype came from the IBA PAS system, and adaptations would be needed to draw data from the newer-CaMIS PAS. The inpatient admission timeline subsequently proved to be a very valuable quick reference tool for hospital admissions, as for example when anaesthetists were reviewing the health of a patient prior to surgery, or as the content of documents in OnBase.

- The appropriateness of our chosen **colour palette** in matters of accessibility, as for colour blind users;

- The use of **NHS Standard formats for fonts and other screen functions**. Shanice Buchan (2014-15 Solent student) had written a very interesting project for us to highlight the benefits of moving to the standard NHS fonts, colour schemes, button design and so on, to improve the institutional feel and embedding.

- **The iconography**. Alan's original freestyle choice of icons for Lifelines 1.0 has been very successful (eg the Xray symbol) and I the palette was very comfortable to use on a daily basis.

- **Optimisation of icon shape, colour, contrast and dynamic functionality**, such as flashing for important unread reports, within the constraints of the 12 x 12 screen pixel size. We subsequently sought professional advice from the graphic design team at Catchy Monkey, who had done other graphic design work for the Trust, but the feedback we received was that there was little that could usefully be done to improve upon our existing design palette..

- **The collapsibility of subject groups on the Y axis taxonomy**. This would restore a very interesting feature of the Lifelines v1 (2010) version, in which Alan had grouped subject timelines vertically (edocs, clinical visits, tests and reports) with a +/- collapse/expand function. This function would help expand the screen vertical real estate to add further timelines and functionalities in due course.

In the context of the work that Toby Cave had been doing on document categorisation in advance of Onbase implementation (Essay 1:8), I wondered whether we could build a system that distinguished documents of transient and permanent clinical utility to minimise timeline overload, and between which the user could toggle if there really was a need to review transient documents.

- There was a need for an "About Lifelines" introductory and explanatory text which could be accessed via a hyperlink. The system has been designed for maximal intuitive use, but it was unique to UHS and would undoubtedly be unfamiliar to new users, who might also have some interest and curiosity in the origins of the system.

The flow of ideas and opportunities for further development continued at pace. David Cable proposed a new round of fortnightly meetings of the team to discuss aspects of IT, and more specifically EPR design. This would allow us to consider issues such as GUI, application functionality and usability, platform interconnectivity and so on. He noted that between us we had no shortage of ideas how things could be improved and putting some slots in our diaries would give us some ring-fenced time. We could set an informal agenda for each meeting and decide who needs to be invited.

On 19th November 2019, in advance of the forthcoming live launch of Lifelines v3 into the UHS CDE, Alan opined that a key challenge was to convince clinicians of the value of having a database that is integrated into the UHS clinician data environment. He felt that "*I don't think UHS is encouraging the development of new HICSS modules ... We should continue to make progress with the Lifelines (v3) pilot and solicit feedback from a range of clinicians stating what changes and additions they believe are necessary to make Lifelines a valued part of delivering patient care for them.*"

Cancer Nurse Records and the Management of Document Overload

The addressable issue of document overload that continued to trouble related to the instruction from on high that all specialist and cancer nurse contacts with patients should be recorded on separate documents, where previously they had been consolidated in paper files or on card indices.

The transfer of such contacts as individual episodes in HICSS and subsequently to the Somerset Cancer Register system had made a major adverse impact in cluttering documents on the Cancer Timelines. I wondered whether it would be possible to create a subsidiary timeline for specialist cancer nurse contact documents.

Alan suggested that if the specialist cancer nursing records were held as structured database data (i.e. text) and not as PDF scans, then it may be possible to aggregate the relevant parts of these documents into a "living document" that we could display in a different way on the timeline. This solution was not further developed.

Lifelines Design and the Documentation of Inpatient Admissions

Hospital admissions generate a flood of documents (notes and test results) which would overwhelm the current Lifelines interface design.

I therefore wondered whether we should build a second version of Lifelines, "Acute Admission Lifelines" directly focussed upon the interface to inpatient admission data, with a much shorter timescale (hours, days and (rarely) weeks. This subsidiary version of Acute Lifelines would be accessible by hyperlink to and from the relevant iconon the hospital admissions timeline.

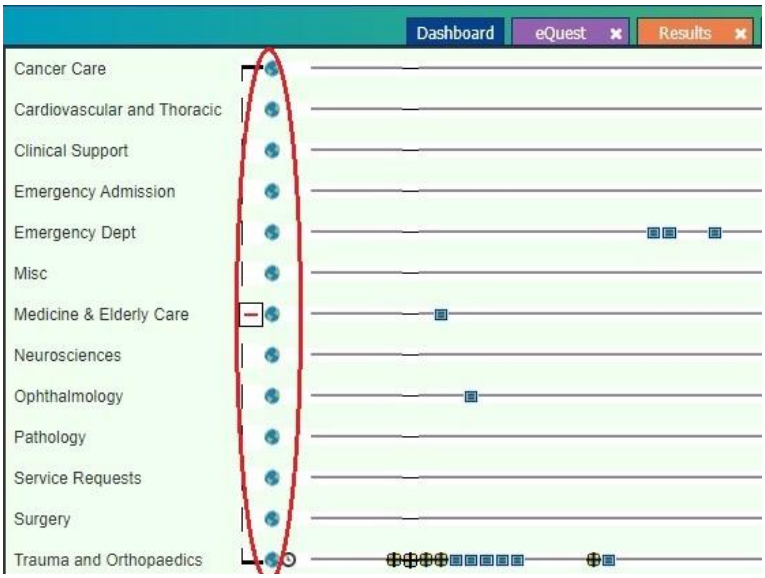


Figure 18: The globe icon at the left hand end of each timeline is a multiple document cluster icon for all documents and reports on each timeline (see text).

Speed-reading of Timelines and the Global Timeline Overview

By December 2016, the tabbed view for document clusters was working very well, and allowing very quick reading through several documents. Dr Ashwin Pinto suggested a useful tool for speed reading through a multiple documents on a busy Lifeline. The facility to create a "super cluster" icon of all documents on any one timeline (for example Surgery or General Medicine), would provide this function. This request was subsequently implemented by Alan and indicated with a Globe Icon. (Figure 18).

Continued Troubleshooting Arising from External Software Changes

Challenges continues to appear as we sought to embed the v3 version of Lifelines into the CDE in advance of its formal launch. On such problem was the loss of one click access to the pre2004 Word documents in eDocs.

Alan investigated why the legacy Word documents have become inaccessible from the new UHS Lifelines, and realised that the legacy Microsoft Word documents (old format with .doc file type) were stored on a dedicated server called RHMPATIENT. He noted that

"If you have retrieved a document from the word document server a while ago, that server will have cached your password at the time, and your current password may now be different.

When you access the document from Lifelines, you get a dialog window with three options, the first is to open the file. This dialog did not used to appear several years ago, but Microsoft have now forced this dialog to appear and as far as I know there's nothing we can do to stop this behaviour.

If you choose to Open the file, your browser will attempt to fetch the file, BUT if your password on the word document server is different to the one you have used to access Lifelines, the document will not be fetched and quite annoyingly you get no error message or a chance to re-enter your password.Longer term, there are better ways to get around this and the very clunky Word/Excel browser integration that Microsoft are now forcing on us.

(A) The legacy word documents may be bulk converted into PDF files. These will open into the browser without needing to fire up MS-Word (it does use the Adobe reader, but this integrates well with the browser).

(B) I have changed the way that the Word documents are retrieved so that the Lifelines web server gets them rather than your browser session.
I will ask our server administrators to allow the web-server to have "read" access to the Word document server so that the credentials of the Lifelines user in future will not be used and won't matter.
Your password on will then be recognised on RHMPATIENT and then you should be OK. You should at least now get an error message if you can't get the Word document because your credentials have not been accepted."

On clicking on one of the legacy document icons, the following text now displayed the text "This document is a legacy word document which cannot be displayed in a browser. If you wish to download the document please click here." The click link then works immediately to open the document. Problem solved!

This incident was one of many similar such problems that arose, and their resolution highlights the huge value of having the software designer intimately engaged with fault finding and resolution from a deep knowledge of the system.

Other Enhanced Functionality in Lifelines v3: Maternity and Obstetrics content
We loaded an **"Obstetric and Maternity" timeline** for the use of gynaecology and obstetric practitioners. This was also expected to help the very active Women's Health research community, and link to the Southampton Women's Survey which was run by the Medical Research Council Lifecourse Epidemiology Centre from a site at SGH..

.

Linkage of the Independent Sector Treatment Centre at the Royal South Hants Hospital
Since 2008, the surgical unit at the Royal South Hants Hospital (RSH) had been run as an NHS funded Independent Sector Treatment Centre under the corporate management of Care UK and subsequently of Practice Plus Group (PPG).

Many NHS patients flip between the RSH and SGH for diagnosis and treatment, and yet there was no formal and persistent exchange between the UHS EPR and the various commercial EPR systems in use at the ISTC.

By December 2016, we had reasonably well established document stream and timeline for Southern Health and for Solent Health. It therefore seemed sensible to link the ISTC document flows with UHS and display them on Lifelines, to the general benefit of the local GPs. I therefore asked whether this issue has yet been explored, and if not, what might be done to explore the art of the possible.

Derek Waller commented that: *"I am trying to find out what the block is for CARE UK sending all letters and summaries to HHR. I was promised that this would have been resolved some months ago, but it sounds as if it is still an issue. Importing their documents into EDMS has not been discussed, although I can see a clinical justification. Not sure what the financial implications would be.*

We set up a workable solution for the duration of the pandemic, but this arrangement lapsed as of January 2025, this issue has still not been satisfactorily or sustainably resolved!

Branding and design protection of UHS Lifelines, and Coding in the Open

We have never formally protected the intellectual property (IP) UHS Lifelines. In December 2016, I raised the matter of trademarking the UHS Lifelines API. I also took advice on patenting from a member of the Government's Digital Catapult last year, whose view was that it should be possible to protect the design features (but not the code) with a European Design rights listing and submission.

Adrian Byrne d agreed in principle to provide funding for the trademarking of Lifelines. Based upon experience with the My Medical Record programme, he recommended that we also look at creating a branded logo to give us more chance of us being awarded the trademark. Alan added text to the Lifelines interface to the effect of '©UHS Lifelines – property of University Hospital Southampton NHS Trust 2010-201(7)'.

On 29th December 2016 Adrian Byrne, summarised our challenges in the field of leveraging the UHS IT expertise for a wider NHS and public sector user base. He noted that:
"We are in a rare, not unique, position with our EPR that allows us to do the things we do both with Alan and our development team. The access to our data model including data that sits under the intellectual property of EMIS is vital to this. There are undoubtedly things that we would like to share with others, and gain their assistance in development. This could include user interface or techniques.

Unfortunately, because of our tightly integrated environment, not much of it could be used as a template for anywhere else. Not much of the code written could run in isolation or on another site with different systems and interfacing capabilities. Systems have evolved in a way that is heading towards what I think is your vision, but are not there yet:

Historically, if you bought an IT system you would have had to buy it on a specific computer, IBM for example.· Along came operating systems like UNIX that allowed you to port software for example to HP, but you were still tied to a vendor and very bespoke data structures, in files.

Databases such as Oracle allowed users and developers to understand and access data even though they were not the author of the main application. In fact our Casemix used to be an application that does not exist any more, we just run the database.
Interface standards such as HL7 allow different vendor solutions to talk to each other
·Interface engines such as Ensemble allow us to manage many feeds and a web of those interfaces

The final piece here is that application vendors themselves must talk to their own platforms in the way that we would wish to interact with that data. Think of it as a layered approach where everything is partitioned: The data and its structure; The interfaces that allow applications to talk to the data; and the applications themselves. Presently, a lot of what applications use to talk to data is proprietary, such as EMIS talking to its own platform, and *UHS using its privileges to talk to a mixture of platforms such as for example IMDSoft Metavision.*

FHIR is a new interfacing standard which aims to break this down so that all of those data accesses will be open. A group that I am closely involved with, INTEROPen, is trying to drive the industry towards this way of working.

If this is successful, it will be possible to port code from one platform to another, in theory. Systems using these standards would be more generally usable and therefore possibly worth hosting in GIT. This does of course require the code also to be open source, which is a different discussion entirely."

I replied to Adrian that:
"Our main effort for the first half of 2017 should be to get UHS Lifelines up and running and widely understood around the Trust.

There are a number of navigation issues in the new CHARTS interface which need to be resolved before we are good to launch Lifelines on the broader kirk of potential users. Alan is still tweaking the system as we identify areas for tidying up.

We know that every hospital will have to find a bespoke solution to its IT/EPR integration, and therefore, it is highly unlikely that anyone would be in a position rapidly to use any code for UHS Lifelines or anything else that we publish.

Nevertheless, given the priority which GDS places on "Coding in the Open" the political gain of doing so may be far greater than we might suspect, and it may well strengthen any future applications for follow on funding to the £10M grant.

It could also help put us further into pole position as a leading IT centre of excellence in the UK at no risk or cost to ourselves. After all, it might be seen as very ballsy and forward thinking to go down this route unprompted.

It may also help lure in third party or hobby coders who might be able to support Alan and do some great stuff for us in due course.

Concluding Comments for 2016 on the Future Role of UHS Lifelines

In August 2016, I had visited the headquarters of Hyland Software in the delightful setting of Westlake Park in Cleveland, Ohio as an invited member of the Hyland Clinician Advisory Board. The board discussed various issues around health systems data system design and implementation. The main focus was the US healthcare market, and clinical informatics representatives from some of the big US Healthcare Corporations (MD Anderson, Cleveland Clinic) were present.

My particular interest was in learning how the Hyland Electronic Document Management System was aligned with the current UHS Clinical Data Environment, and how their OnBase EDMS would link now and how it might evolve. We appeared to well ahead of the US providers with UHS Lifelines as a concept and as a functioning product.

Alan subsequently commented that: ”I *would be very surprised to see any software suppliers with clinical interfaces that rival what we have developed. UHS enjoys a level of implementation and integration of operational systems linked to a central patient master index that most organisations could only dream about.*

The UHS situation is way beyond the conceptual or academic with many years of primary clinical data held in modern databases...The position that UHS enjoys is not something that an IT supplier can deliver in isolation, and most suppliers don't understand how to work collaboratively with healthcare providers...”

On 30th December 2016, I noted the importance of the Trust having a fallback plan for if and when the Onbase system did not deliver the user experience in terms of interface design and functionality for which we hoped, and wherein I had expended considerable time and effort in discussions with the Hyland development team.

I was aware from conversations at Hyland that the timeline view in OnBase which we were initially shown was a mock-up. I did not believe from my in depth conversations in Cleveland that they had any practical experience at that time in working with such a visualisation system in clinical practice.

I was also concerned that the plan to get OnBase up and running as a fully fledged system with eDocs migration during 2017 was very optimistic, given that their proposed interface was largely untested, unlike UHS Lifelines, for which we now had five years of progressive development testing, iteration and experience.

It therefore seemed likely to me that there the Trust might well need to fall back on UHS Lifelines as the primary EPR interface, at least temporarily and possibly in the long term. UHS Lifelines already existed, it worked and it had been well tested.

Specifically, I recommended to the team that we should reserve the option and consider how best to import and display key backload and scanned documents into UHS Lifelines as a priority and as a safety net for the Trust. A small investment in this project should provide a valuable and face saving fall back position if the Hyland model did not evolve as hoped.

AN INTERFACE IS WORTH A THOUSAND PICTURES

On 30th December 2016, I alerted Alan and David Cable to my discovery of an original Lifelines video on YouTube from the University of Maryland Team. I noted that although it is date and the reproduction were poor, there were still a few ideas which we could bring up to date in UHS Lifelines in due course. https://www.youtube.com/watch?v=aeRklur2Zc4

By the end of 2016, Version 3 of Lifelines was up and running in the CHARTS EPR wrapper and the UHS Clinical Data Environment in a format which was accessible to all staff at UHS for familiarisation, testing and user feedback. I was confident in my view that while a picture may be worth one thousand words, a well structured Lifelines interface was worth 1000 pictures.

References

Rew DA, Hales AA, Cable D, Burrill K and Bateman AC: New life for old cellular pathology: a transformational approach to the upcycling of historic e-pathology records for contemporary clinical uses Journal of Clinical Pathology: 16 February 2021. doi: 10.1136/jclinpath-2021-207385