Principia Medicinae Digitalis Sotoniensis

A History of Healthcare Computing and Advances in Clinical Information Productivity in Southampton, 1980 -2024

Essay 4: Evolution of the University Hospital Southampton Clinical Data Estate from 2010 to 2021

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I will be pleased to hear from anyone who can contribute additional insights, documents and imagery to amplify the existing content.

Key Words
Electronic Patient Record; eDocs, HICSS, eQuest, UHS Lifelines; UHS CHARTS.

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Abstract

The era of worldwide digital transformation since the 1940s has created huge opportunities for improving information flows around the global healthcare ecosystem, and for increasing clinical productivity, clinical safety and the lives of all citizens.

Healthcare is a particularly complex environment for which formulaic programming methodologies and hierarchies are inadequate to deliver the “best in class” and truly “digital by default” solutions which would be beloved of their users.

There is therefore an enduring requirement for an efficient Electronic Patient Record (EPR) which is fully optimised for healthcare professionals and their support teams. The bespoke University Hospital Southampton (UHS) EPR remains among the most advanced, efficient and user friendly software systems in its class on a worldwide basis.

Most commercial systems and the top down programs which have been mandated by Government bureaucracies have generally lacked truly agile and iterative development with continuous end user input. Unusually, the University Hospital Southampton (UHS) EPR was developed in house and at very modest cost through a close working partnership between locally employed IT professionals and the end users in all applications and subject fields, and many voluntary inputs.

However, this uniqueness also remains a vulnerability, in that the high level demand for greater systems integration across the NHS might yet be accompanied by enforced substitution of the Southampton system by a nationally imposed but less well adapted EPR.

The need for a history of what has gone before is therefore as important as ever, so that our successors can understand the foundations and the philosophy of the system that they have inherited and may wish to defend, and so that others might learn from our collective work.

This is the fourth essay in this series on the history of digital transformation in Southampton in which review of the developments of the UHS EPR between 2010 and 2021. Over this time the fully formed and integrated hospital EPR emerged.

Introduction

In previous essays in this series, I have described the evolution of the Clinical Data Estate (CDE) of University Hospital Southampton (UHS) from the late 1980s to 2010, and the development of a series of core systems which are necessary to constitute a functional EPR in a major University Hospital in the UK.

The UHS CDE escaped the widespread dislocation of the NPfIT programme of the 2000s without having a commercial system imposed upon it, and with 15 years of consistent development and standardised clinical documentation to build upon. The IT department was now well established around a core of experienced and committed developers and system owners, under solid leadership with a clear strategy for further consolidation and the development needs of the project. A growing number of clinicians with particular interests in IT systems were engaged with the IT team and made welcome.

The IT team also had the confidence to endorse and undertake imaginative projects and a test environment or early “digital twin” of the working system within which to experiment, working in partnership with health professionals from many disciplines across the hospital.

By 2010, the core component systems of the Southampton Electronic Patient Record were largely in place and functional. Of particular significance to clinicians and their teams, the Hospital Integrated Clinical Support System (HICSS), the eQuest Ordercomms system and the eDocs Document creation and classification systems were well established within a HTML enabled networking environment. Importantly, they were linked by a common design philosophy and code base on a common integration platform.

However, this was not yet a unitary system which was optimised for the clinical end user. Each module (eDocs, eQuest, HICSS) still stood alone. Users would have to open each module in turn to perform their daily functions, with separate logins for each module. This imposed significant operational penalties on the users in terms of the screen time spent discovering and integrating key documents at every clinical consultation or other patient-facing activity.

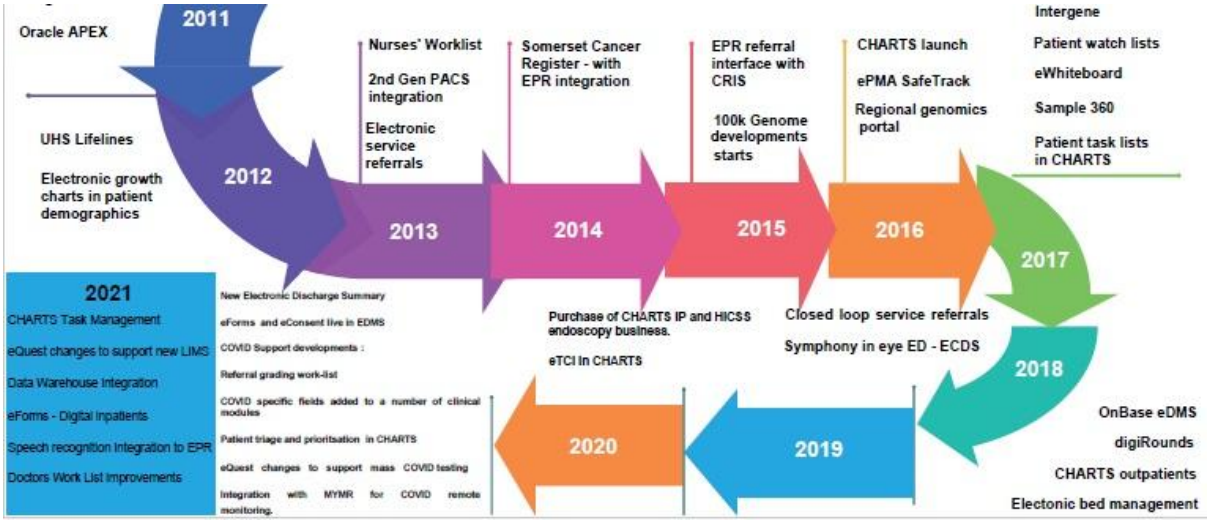

Figure 1: The flow of developments to the UHS Clinical Data Estate, 2011-2021 (Courtesy of David Cable, UHS)

The decade from 2010 to 2020 saw a major transformation from a disjointed to a wholly integrated EPR across the hospital, through a cumulative series of software innovations and acquisitions, while the global commercial computer environment continued to evolve rapidly. The foundation software and operating system environment upon which the system was founded changed rapidly and often in destabilising ways.

For example, Microsoft regularly updated its Internet Explorer operating system (OS) and programming tools (such as from MS.ASP. MS DotNet), and the MS Edge browser superceded Internet Explorer. Google Chrome emerged as a competitor with different core functionality, while, the Mozilla Firefox browser remained popular as a free-to-use browser in personal applications.

As each change of browser or other externally supplied software was imposed, new bugs, instabilities, broken links, incompatibilities and frustrations were generated. Occasionally, network outages would cause significant short lived disruptions to clinical services, particularly when new versions of systems were launched, which testing had not detected in advance. However, with the complexity of launching into a live and high demand clinical environment, unforeseen problems would be bound to arise and needed rapidly to be resolved.

Adrian Byrne, who was the Trust's Chief Information Officer from 2004 to 2023, recalls that "we were early to the HTML environment and the browser standards that we now rely upon were not that well set. We were probably saddled with more legacy software debt than those hospitals which came later to the EPR development game".

My own involvement with the UHS Digital IT team started in practice in and around 2008, when I was pressing persistently for a modern data system for the Southampton Breast Cancer Service and making a nuisance of myself with the IT team. I had identified Dendrite Ltd as a suitable provider, as the company which had built the national cardiothoracic surgical audit system. I was initially unaware of the local UHS IT strategy to build integrated systems within HICSS wherever possible.

My discussions with David Cable, senior IT manager, and with Adrian led to my introduction to Alan Hales, who had done much of the heavy lifting in designing the key UHS component systems. This teaming led to a hugely productive decade of innovative systems within the UHS EPR environment. Within this subgroup, our developments included UHS Lifelines in 2010, the Breast Cancer Data System in 2012 and the enhanced Somerset Cancer Register module (SCR Plus) for Cancer Multidisciplinary Teams (MDT) system in 2019. I address these systems in much greater detail in subsequent essays.

UHS Lifelines (2010 onwards) was of particular relevance to the evolution of the EPR. It demonstrated how simple and elegant software design could provide a unifying and intuitive interface design to the EPR. It integrated a wide range of content from the Patient Administrative System (PAS); from the eDocs common document management system, eQuest order communications system; and from legacy histopathology records and radiology reports into a single dynamic, navigable and interactive interface. This offered huge productivity gains to the Trust in minimising the time wasted in "manual assembly" of the EPR during each and every patient contact.

The Oracle APEX system of systems (2011 onwards) was another important home-grown system. I am grateful to Dave Waghorn of the IT team for recording his stewardship of this wide ranging programme in another essay in this series.

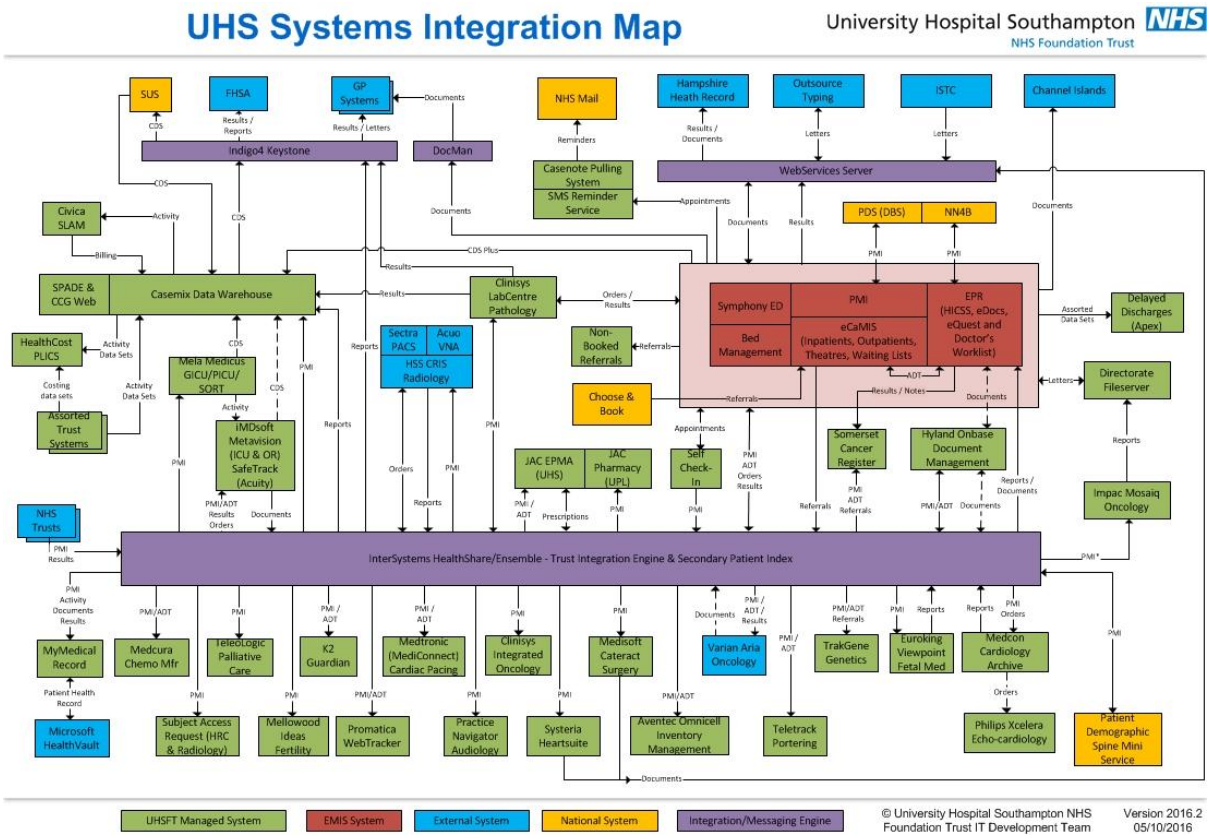

Figure 2: The Architecture of the UHS Clinical Data Estate in 2016. (Courtesy of Ian Brewer)

The "plug and play" technical architecture of the UHS Clinical Data Estate was also well established by 2010 onwards. In this model, the primary Integration Engine data spine for patient identities, linked into any number of suitably configured primary, secondary and sub-speciality systems could be plugged. Ian Brewer's diagram highlights just how many other systems were integrated into the clinical data estate by 2016 (Figure 2).

These included the data spine engine, along with the Indigo4 Keystone and Docman engines which interfaced with GP records, and the Web Services Server, which interfaced with the Hampshire Health Record and the Treatment Centre at the Royal South Hants Hospital.

Commercially managed systems, highlighted in blue, include the Microsoft Health Vault, the Varian Aria Oncology System, and the Sectra, Accuo and HSS CRIS Radiology systems.

Externally supplied but UHS Managed systems, highlighted in Green, included the Somerset Cancer Register and the Hyland OnBase document management system.

The key clinical EPR systems, highlighted in pink and brown in Figure 2, were supplied in 2010 by Ascribe Ltd, and subsequently their ownership was taken over by EMIS ltd. They included the Symphony Emergency Department system, eCAMIS, the Patient Master Index, the Bed Manager system, and the HICSS, eDocs, eQuest and Doctors' Worklist systems.

The system was also linked to a collection of National Systems (yellow/orange), including "Choose and Book", NHS Mail, and the Patient Demographic Spine mini service.

The clinical data estate was managed on local computer Servers, which were initially linked by a hard wired Ethernet network to Dell PC terminals. Wireless networks and the support for wireless enabled devices were progressively introduced with mobile devices, including laptops, iPads and smart phones.

In this essay, I will introduce the various component systems as they were added to the UHS Clinical Data Estate by year of acquisition.

Developments in 2010

The eCamis Patient Administration System (PAS) Inpatient and Theatre Modules

The Trust went live with the Ascribe eCaMIS Patient Administration System in 2010. Its functions included inpatient, bed management, clinical record tracking, waiting lists, ward attender listings, an Operating Theatre administrative system and a Clinical Viewer. The system was also designed to support paperless working. The implementation included two new modules, **Waiting List** and **Ward Attenders**, which were specifically designed for UHS.

The Electronic Patient Discharge System (eDischarge)

This system went live with key contributions from principal pharmacist Mark Pepperrell and from eRecords projects analyst Nilesh Patel. Patients received a printed copy of their admission record on discharge from hospital. Discharge information was also made available through the Hampshire shared record initiative.

UHS Lifelines: In September 2010, the first version of UHS Lifelines was presented to the Trust's Information Management Group.

Developments with UHS Digital Systems in 2011

Doctors Worklist (DWL)

This was built in house as a desktop system for systematising the daily workloads of junior doctors. It listed patients for whom they were responsible under a single sign-in, so as to improve and systematise the handover of patients to incoming medical staff at the end of shifts. The Doctors Worklist interface listed every patient, along with links to eDocs, eQuest and other clinical information resources.

Dr Derek Waller was instrumental in this project. DWL was developed for the particular purpose of supporting The "Hospital at Night" programme as one of its key drivers.

"Hospital at Night" (H@N) was a national initiative which dated back to 2003. Compliance by NHS Hospitals was measured by national bodies, including the Care Quality Commission (CQC). Aisha Saqib and colleagues (Saqib et al 2021) note that the introduction of European working time directive in England in 2003 had led to a reduction in working hours for junior doctors from an average of 78 to 48 per week.

In England, the pressure to reduce junior doctors' hours prompted the national project sponsored by the Department of Health: hospital at night. H@N was a multi- professional, multispecialty approach to delivering care at night and out of hours, with the aim of improving patient safety, when few consultants were in the hospital, and when the duty doctors would be unfamiliar with the case histories or needs of many of the patients who they inherited at the start of their shifts.

The Oracle APEX (APplication EXpress) Information Management System

Oracle APEX is an enterprise low-code application platform for the creation of scalable, secure web and mobile apps. It offers an intuitive, graphical and consistent development user interface. The history and detail of this system at UHS are discussed at length in a separate essay in this series, authored by Dave Waghorn as the IT lead for the implementation of the system. Adrian Byrne notes that the Oracle APEX portfolio of systems has offered key operational benefits to UHS as it can reference the same data tables directly as the EPR, with Microsoft tools interfacing directly to Oracle.

The JAC Electronic Prescribing and Medicines Administration (EPMA) system.

Electronic Prescribing and Medicines Administration (EPMA) systems were widely adopted across the NHS around 2011/2012. The UK supplier, JAC is now owned by System C. UHS was already using JAC's Pharmacy Stock Control system in 2011.

The JAC system proved difficult for clinicians to use, and it did not link directly into existing systems, including the HICSS-based discharge summary. Adrian Byrne reflected on the challenges of support for electronic systems across hospitals, using the example of e-prescribing, in a blog post on the Digital Health website in January 2014, as follows:

" E-prescribing. It means having a team available to deal with problems as they arise, backed up by 24 hour supplier contracts. In Southampton, we have core IT teams for the network, databases, servers and so on. Then we have a patient administration system, emergency department and electronic patient record teams, a digital imaging (picture archiving and communications and radiology information system) team, a pathology system team, and an e-prescribing team.

One benefit of the larger EPR system (the commercial "megasuite") approach is that, by default, you end up with fewer of these teams from the outset. But a key challenge to the rest of us is to understand when it is right to start bringing components together to provide a more robust service whilst also saving money. However, in University Hospital Southampton, the e-prescribing team is based in pharmacy, while the PACS team is based in the radiology department. Those who work in the systems teams also carry out important functions within those departments, with their very different specialist knowledge sets.

Would creating a unified response team dilute this expertise too much? Maybe; but we cannot keep growing the number of specialist support teams: the next system for us to support is a critical care system across multiple units that will cover around 100 beds.

We are also told that the hospital has to provide the same service over seven days per week, and IT support will have to reflect that. We cannot carry significantly more real risk in the out-of-hours function. Ultimately, I think we are going to have to improve our analysis of the

systems risks that surround us while we improve the level of functionality of the systems themselves. We will have to make some uncomfortable compromises for the greater good".

Staff accreditation and training for IT Systems

Adrian further reflected that *"A particular operational problem is how to deal with temporary staff and locums as they arrive on site to cover a shift. Anonymous access to clinical applications cannot be allowed, as we need to be sure that whoever is logged as looking at a record is indeed that person.*

We also need to know that whoever has access to a system is trained and understands how to operate it. However, a suite of clinical applications, including discharge summary, drug and pathology test orders, will take many hours to train fully. For a locum session, there clearly is not enough time for this. Therefore, we must compromise on trade-offs between the risk posed by users who are not "fully" trained, and the risk of them not being able to do their job at all because they cannot access a system because they lack the "full" training.

We regard the primary e-prescribing risk to be a potential lack of system-trained staff on the ward. We do not believe that we can say "you are not allowed to work on there if you are not fully trained in the IT systems." Even if we did, it would become inevitable that local needs would push some users into logging-in and leaving their sessions open for others to use, or into sharing their passwords.

We have therefore been considering what level of expertise you really need in a system in order to use it at all, and whether there are associated access permissions for a particular module or level of training. The learning associated with different modules will, of course, be e-learning and be available on the internet wherever possible.

The trickier issue is the levels of access available in any system, as these do not always present themselves in the ways you would wish to set up users. For instance, at a very basic level there might be an option to 'view only'. However, in many cases, 'view only' access would not be enough to enable users to perform their clinical roles."

e-learning modules for e-prescribing

Adrian wrote that: *"We have e-learning modules for e-prescribing, and it has been agreed with our nursing agencies that all agency staff will complete their training – which is available on the internet, outside the trust, prior to starting a shift.*

This has worked well. However, the remote e-learning approach has not been so successful with locum doctors. We still end up with people arriving to work who we have not seen before... we've found that locum doctors will tend to need to complete this training once they are at the hospital. ... these are real, practical issues that those who are embarking on e-prescribing and similar projects will have to confront at the grass roots level.

There is no utopian "know all, train all" support available; and even if money were no object this would still be difficult. When I was a kid, I used to watch Joe 90. He had a machine that he could sit in it for a minute and come out as a fighter pilot [or a doctor?]. We really need one of those, but for now, we are going to have to do the usual things – recognise the problem, analyse and scope it, perform risk analysis and options appraisal, and come out with a somewhat imperfect best fit".

https://www.digitalhealth.net/2014/01/ade-memoire-3/

The SUHT Performance Assessment Data Evaluation (SPADE) system (2011)

Kevin Hamer of the IT team described SPADE, the SUHT Performance Assessment Data Evaluation system, to me as "*a web based management reporting tool that had been internally developed by the Trust since 2001, for access from any networked PC across the Trust. It was born out of the need for Information Managers, Executives, Clinical Service Managers, Clinical Service Directors and others to assess performance in key areas across the Trust, from one central system.*

The initial development of SPADE was driven by Chris Canning, former Lead Ophthalmic Surgeon in the Eye Unit, who formulated the original specification. The first draft of SPADE focussed on reporting performance activity versus targets.

The product continued to develop after 2001. By 2011 It hosted more than 250 pages, which addressed activity reports and operational matters, predictive measures and data quality. Many pages also offer interactive features which allow users to search and analyse to specific data sets."

Developments of UHS EPR Systems in 2012

The HICSS Paediatric Endoscopy module (2012)

The commercialised HICSS Endoscopy software system continued to evolve. In 2012, the paediatric version went live with additional functions to access to patient details from the PAS; to record patient interventions; to capture images; to record findings; to link to case notes and histology forms; and to generate standardised reports.

The Hampshire Health Record and the UHS Clinical Data Estate (2012)

The Hampshire Health Record HHR) project started in 2005. It was linked to the UHS EPR in 2012 with the support of the NHS South Commissioning Support Unit. It was built on commercial Graphnet technology and used the NHS Number to identify patients. It reported care encounters, GP diagnoses, blood and radiology results, current medication, allergies, clinic letters, discharge information, and some social care information. It was linked to the Adastra system for use by local Out of Hours doctors, and evolved into the Care and Health Information Exchange (CHIE).

Electronic Growth Charts (2012)

Growth Charts are a key element of the mapping of the development of every child, and they are used to follow the progress of healthy children and of those of children with growth disorders. They can also be used to detect illness and malnutrition and to follow progress on treatment.

Professor Justin Davies, Consultant Paediatrician, reports that an electronic API version of the traditional printed and hand-completed growth chart was developed and built in partnership with EMIS Health. David Cable oversaw the project and was particularly pleased with the successful outcome of the e-Growth Charts project.

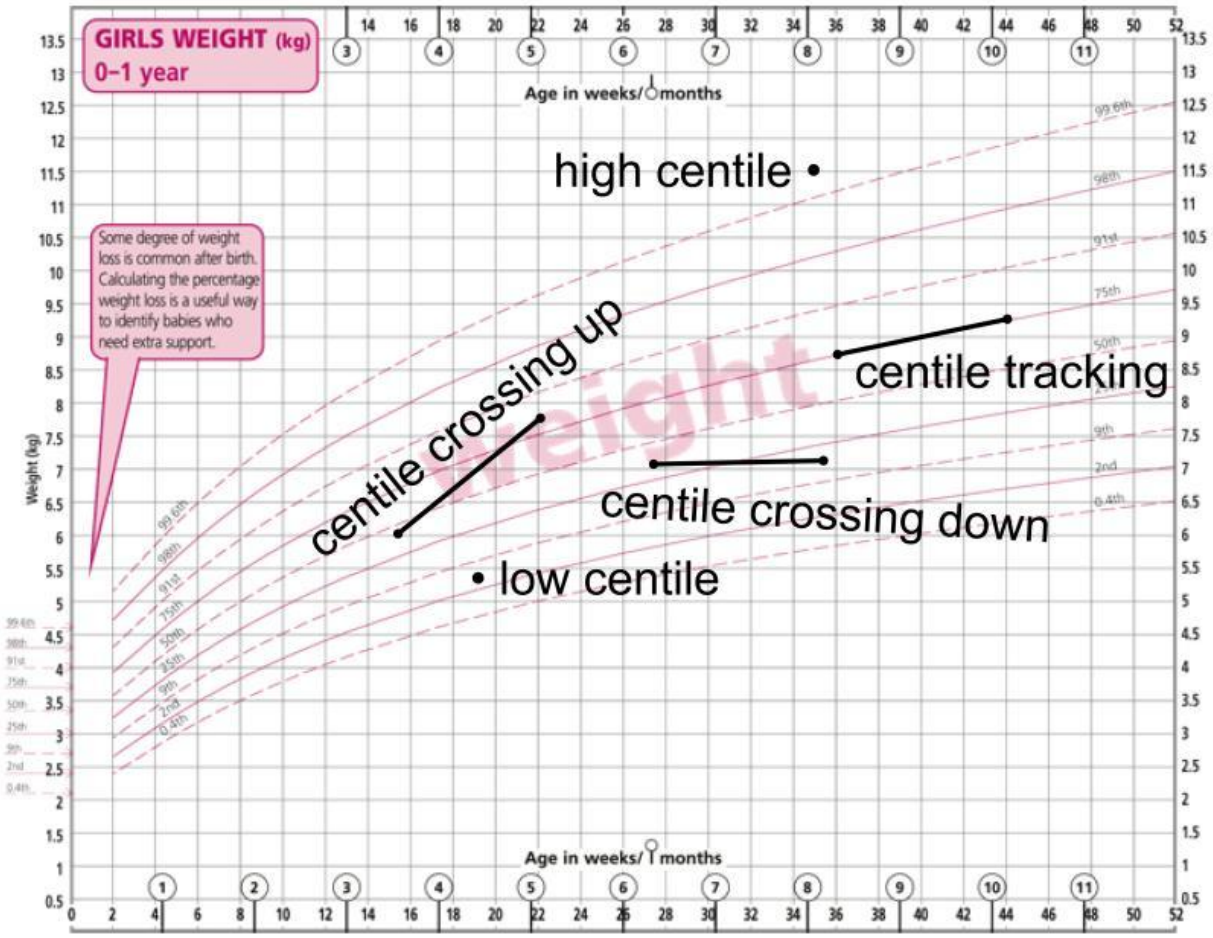

Figure 3: Exemplar of a standard growth chart: Image credited to T J Cole (see references)

MyMedicalRecord (MyMR) (2012)

MyMedicalRecord (MyMR) is a public facing App which allows any patient of the Trust who has signed up to it to access a wide spectrum of personal information, including alerts and appointments. The system was developed in house by Kevin Hamer and colleagues on Microsoft's HealthVault platform, with help from US Company "Get Real Consulting". It went live in 2012 and has since evolved into a standalone product which has been made available to other healthcare providers.

Adrian Byrne recalled the philosophy behind the MyMedicalRecord project and his thoughts on Federated Identities in his Digital Health blog in November 2013: He wrote that:

"We have worked with Get Real Software's Instant Personal Health Record, to link the trust's Electronic Patient Record with the Microsoft HealthVault platform. Early on, we realised that it would be difficult to identify patients and link them safely with their UHS record.

We then recognised the value of creating an account that could authenticate a user across a number of different healthcare sites. We decided that a UHS identity would be difficult to sell to the wider market, so we sought a commercial system that would meet our needs.

The Get Real Software product (the Instant Personal Health Record) is a content management system that can be used to build pathways. It comes with a number of functions such as a "questionnaire" and a "diary". The link to HealthVault allows patients to share information with others and to input health readings from appropriate devices.
It gives patients their own identity and personal health record. They can then choose to link with any number of compatible sites, and to share their information with whoever they choose. There is now also a mobile app.

We chose to work with two of our clinical teams on the initial proof of concept and have around 50 patients with inflammatory bowel disease and maternal (gestational) diabetes on board. This has been a difficult project to manage in terms of predicting benefits, but I am reminded of the philosophy that both Facebook and Twitter adopted when they first launched. Get the users on, and using what you have, start to exploit the benefits.

Small groups of very interested patients who have long term conditions stand out as a clear opportunity, but that doesn't really take us to the numbers we wanted to achieve. In the short term we would like to grow the existing 50 or so proof of concept users up to around 5,000 registrants... What is it that makes a patient want to sign up to a health organisation's website, and how do we encourage that before we have even seen them?

Our patients attend 350,000 outpatient appointments per year, and there are many things that a patient could do with an account with a provider website like ours. These include: Making sure that hospital-held data is accurate; giving consent to others to see and share data; signing up for clinical trials; saving clinic time by filling in forms online; completing questionnaires for outcome feedback; making use of online messaging and consultation; and exchanging documents, such as copies of correspondence and discharge summaries. Some of this is trivial, once the patient is online, whereas some of it requires complex functionality or interfaces.

Broadly speaking, sharing data, improving data quality, and form filling are simple, as is exchanging documentation such as letters and discharge summaries. Booking of appointments is quite complex due to slot availability and other issues; and you need to persuade the supplier of the Patient Administration System to build you an interface".

One set of credentials for patient interactions with NHS Information

"If a patient has been referred to see a consultant in outpatients, they will be hoping for a quick turnaround. Why would they want to go through the rigmarole of creating an identity just so they can fill out assessment data for us?

The e-Referrals project has a strong link with an appointment cancellation and rebooking piece, for which we have purchased an interface with our eCaMIS patient administration system. We will allow patients who have registered with our website to use it. Hopefully it will be popular, and a trigger for registration.

However, if, nationally, we are going to have a system that patients can log-in to and manage their booking, then we definitely do not want them to have to create another account to log-in to our [University Hospital Southampton] website when they come to have treatment with us".

Federated Identities for Patients

"Patients should be able to use the same credentials, in a so-called federated identity structure, to log-in to both the e-Referrals site and the other services that deliver their care. This is possible; but it must be put in place at design time, otherwise a valuable opportunity will be missed. It would be so much easier for secondary care providers to pick up the online service with patients who already have an Online Identity.

A patient's interaction with us, as with any trust, is hopefully a swift encounter with a few visits and no long term relationship. In my own online life, if I am purchasing a one off item from a website then I will usually try to complete the transaction without creating an account. I don't want many random shopping sites holding data about me, and there is no point in saving account details and passwords for sites that I do not intend to use again".

Federated identity

"I predict similar behaviour with patients and secondary care websites. I therefore believe there are good reasons for having a persistent identity which could also be used to access GP data. Credentials that are used for multiple purposes will have a higher sense of value. Federated identity is not a new concept. Many readers will be familiar with using their Facebook credentials to log-in to other sites, saving the hassle of using many passwords.

The Microsoft HealthVault platform supports the idea of a federated identity, because it provides a service comprising three main elements:
- a common single set of credentials (user ID, password) for a connected service;
- a personal health record containing a subset of the patient health record, and
- connectivity to a range of devices that exist on the high street.
The personal health record can be shared with healthcare organisations, family members and so forth. While the connectivity means that trusts like UHS can pick up the transmitted data, and use it for monitoring and decision support functions.

We do not yet have all of these functions to create single consistent NHS identity. The federated identity could be provided in a number of ways; Open ID would be an alternative. I would like to see us taking opportunities as they arise. The creation of one, consistent NHS identity would in my view transform the user experience of the NHS for the better. It may also help all health care organisations to get their patient services online".
See https://www.digitalhealth.net/2013/11/ade-memoire-2/

In 2019, My Medical Record was made available to all patients of the Trust. Adrian observed that: "*MyMR really is leading the way in working towards a virtual hospital environment which gives patients much more control over their healthcare and better accessibility to their clinical teams and health record*". See:
https://www.digitalhealth.net/2019/03/university-hospital-southampton-mymr-expansion/

Adrian's ruminations on this matter can be seen subsequently to have been both far sighted and influential, in that they anticipated the development of the NHS App and its rapid adoption during the Covid Pandemic.

The 2nd Generation Picture Archiving Communications System (PACS) (2012)

Adrian recalled that the SECTRA PACS system was acquired for the radiology service by UHS in 2012 and it remains in use. Subsequently, the SWASH consortium of the Salisbury, Wight and South Hampshire NHS Trusts was created to help manage large contracts for shared technologies and services in the Hampshire and Wiltshire area. The participating hospitals have shared a contract for SECTRA PACS since 2013.

Adrian nevertheless observed that local purchasing and contracting networks such as SWASH were handicapped by the different geographical boundaries and jurisdictions of the healthcare purchasers. Therefore, the Integrated Care Boards, successors of the Clinical Commissioning Groups in 2022, which in turn succeeded Primary Care Trusts in 2012, which in turn succeeded Primary Care Groups after 2002, are defined geographically by Local Authority Boundaries.

However, different components of the Radiology networks fall under different regional funding arrangements across Hampshire, Dorset and Wiltshire, which significantly confuses flows of money to the providers. Similar confusion undermines other networks, including the Pathology, Network, the Wessex Cancer Network and the Cardiac Services Network.

Developments with UHS Digital Systems in 2013

The Nurses Worklist was introduced in 2013. It had similar functions to the Doctors and Outpatient Worklists, in provided structured work plans for the patients under any individual's care for the current session or work shift.

Elsewhere across the system, work continued through 2013 to integrate the new SECTRA PACS system, and a system for electronic service referrals was developed.

Reflections on the UHS Electronic Patient Record Strategy in 2013

On 5th April 2013, Cambridge University Hospitals NHS Foundation Trust (which includes Addenbrooke's Hospital) signed the contract to purchase the Epic Electronic Patient Record (EPR) system. The The total investment for the "EPIC eHospital" programme was reportedly approximately **£200 million**, which covered the purchase of both the Epic software (roughly

£60 million) and the necessary IT infrastructure provided by Hewlett Packard (roughly £140 million). The system went live in October 2014 and attracted reports in the national media about the disruption which the initial implementation caused. The lessons learned at Addenbrookes and the subsequent positive adaptation to the system were recorded three years later in the Digital Health e-Newsletter in August 2017: see https://www.digitalhealth.net/2017/08/three-years-on-cambridge-epic/

Adrian Byrne's Reflections in 2013 on the Challenges of System Integration

Adrian reflected at length in October2013 in the Digital Health e-Newsletter on the relative merits of purchasing of single monolithic external EPR systems, when compared with the incremental model of local development in detail of the UHS CDE. He wrote that:

"At UHS, we have been working for many years on what used to be called "an incremental model" (of electronic patient record development). However, when you start to mix applications together, you have to manage an increasingly complex set of overlaps.

This is the reality of what now seems to be called 'best of breed', or 'connect all'. In addition, if you have already interfaced and integrated a discharge summary product with a patient administration system, order communications system and theatres data, you are dictating to the next supplier (for example, of the e-prescribing module) that they must adapt to this. In doing so, you may have to accept that you are not going to use all of the functionality in their system. You may also have to build and maintain many interfaces.

Still, the aim is to make everything work as if the whole were a single system. Decoupling parts of systems, and running them without certain key functions, can be quite challenging when they were built with particular workflows and logic in mind.

Users also need to log-in, search and then navigate functions without repeated authentication challenges, different user interfaces, or the need to complete a marathon training programme".

The Pros and Cons of System Integration

Adrian continues*: "The model that we have been following in Southampton can be shown to have fundamental weaknesses. Decision support could be difficult to deliver, and the overall support effort of keeping it all going may become a burden.*

It may seem logical, instead, to put as many eggs into the one basket as you can through a 'single-supplier' EPR; and I can see the case for doing that. Those who have built incrementally may feel disadvantaged when more complete EPRs are proven to work in UK hospitals. However, nothing is as simple as it seems. A large single product, which may or may not be modular (even if it is badged up under one supplier name), requires a large degree of tailoring for an installation, and this can take a number of years.

Installation itself may be very difficult.... The decisions that an organisation makes should be based on many factors, including its ability to deliver the necessary integration to a satisfactory level. Indeed, many suppliers are working with quite dated technologies".

Bringing it all together

"We have worked with our main EPR vendor, Ascribe, to bring all of the products that we built under a single framework. Some would call it a portal, but I hesitate to use the word. The main thrust of this is a component that gives doctors and other clinical staff a "list" view of the world, based on their team, ward, consultant or operating mode.

From here, they can carry out a range of tasks, complete assessments such as for Venous Thrombo-Embolism (VTE) (the risk of a patient suffering a major blood clot); look at history (including the local Hampshire Health Record summary record); acknowledge results; order investigations; and prescribe in a third party embedded application, such as JAC.

When a patient is selected, they stay in context across the whole suite of applications, and a user is prevented from seeing different patients in different modules.The level of integration required to achieve this, along with the underlying interactions, is what makes me quite nervous about the word portal. I am concerned that 'portals' can be used to paste a layer of veneer over systems, while offering only restricted functionality."

In three years, a lot can change

"The choice that faces us now is whether to continue with what we are doing, or go out and try and buy something that does it all? I am swayed by two main factors.

Firstly, can we pursue our current route or should we be testing the market?

Secondly, if we bought something, would it be as good as what we have at the moment? ....

We tend to work on a three year horizon in terms of funding and technical/product direction. Sometimes, we have to accept that we don't yet know what the next step will be, and that is not easy in strategic planning terms."

https://www.digitalhealth.net/2013/10/ade-memoire/

Developments in the UHS Clinical Data Estate in 2014

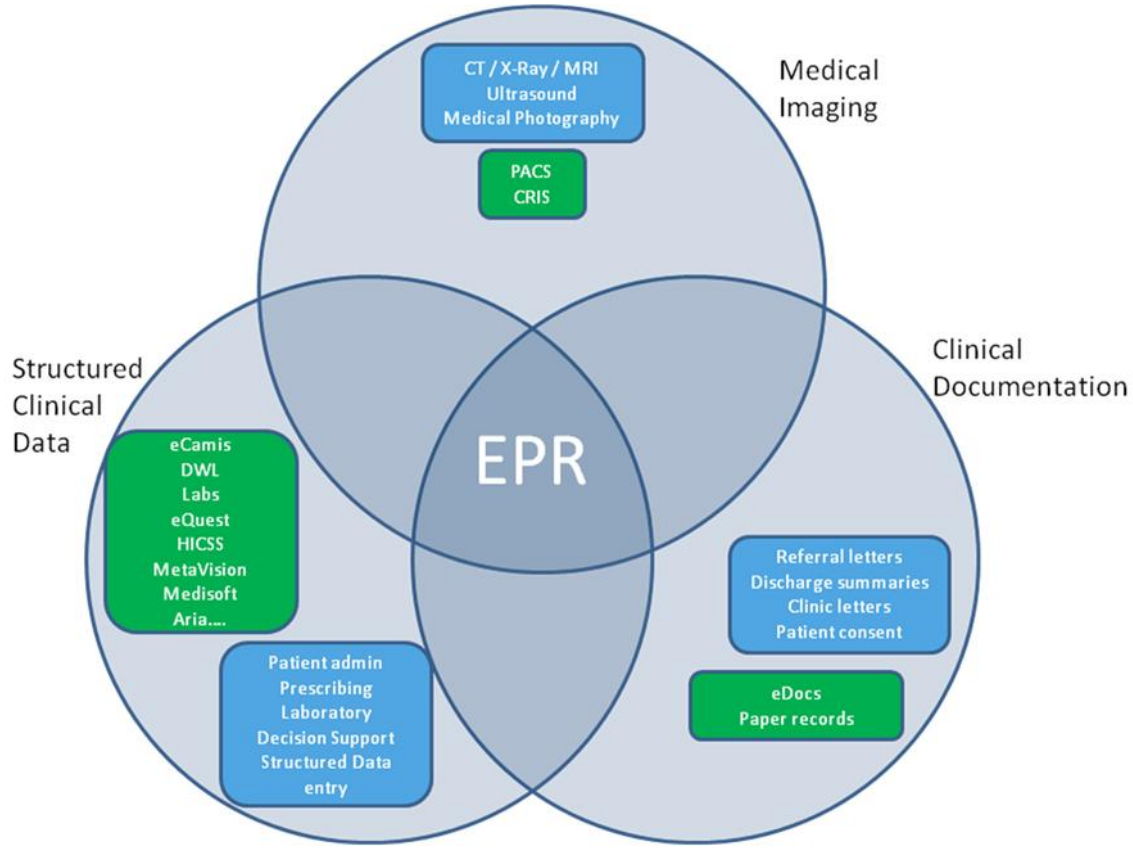

Figure 4. Venn diagram of the UHS EPR in 2014, courtesy of Toby Cave of the UHS IT team

By 2014, the component systems of the UHS EPR were in place, as illustrated in Toby Cave's diagram (Figure 4.). However, the collection of subsystems still lacked an integrative wrapper in the form of the CHARTS wrapper, and UHS Lifelines was still under development. Key acquisitions included Metavision SafeTrack system and the Somerset Cancer Register.

The Metavision SafeTrack system for Intensive Care Units and Wards

Metavision was purchased from IMD-Soft in 2014 for the integration of data on vital signs and nurse-generated information on hospital wards. It could also generate automated Modified Early Warning Score calculations and other alerts. It replaced paper records with hand held devices across 57 wards for some 3,000 nurses and midwives. It was extended to the Paediatric Intensive Care Unit in 2018.

Height and Weight measurements

The regular and accurate recording of a patient's height, weight and BMI in an easily accessible format for staff is an under-rated activity which provides important proxy insights into human health in children and adults.

In April 2014, Alastair Marchant of the IT team informed us of his work to promote the use of the Measurements tab in the EPR Clinical Systems to record and view patient height and weight, and the derivative Body Mass Index (BMI). Alastair located the Measurements tab to be available on the Patient Details screen in eDocs, eQuest, HICSS, DWL and eCaMIS. It allowed for a height and/or weight to be entered for the current date or for any date in the past and for the BMI to be directly calculated (Figure 4).

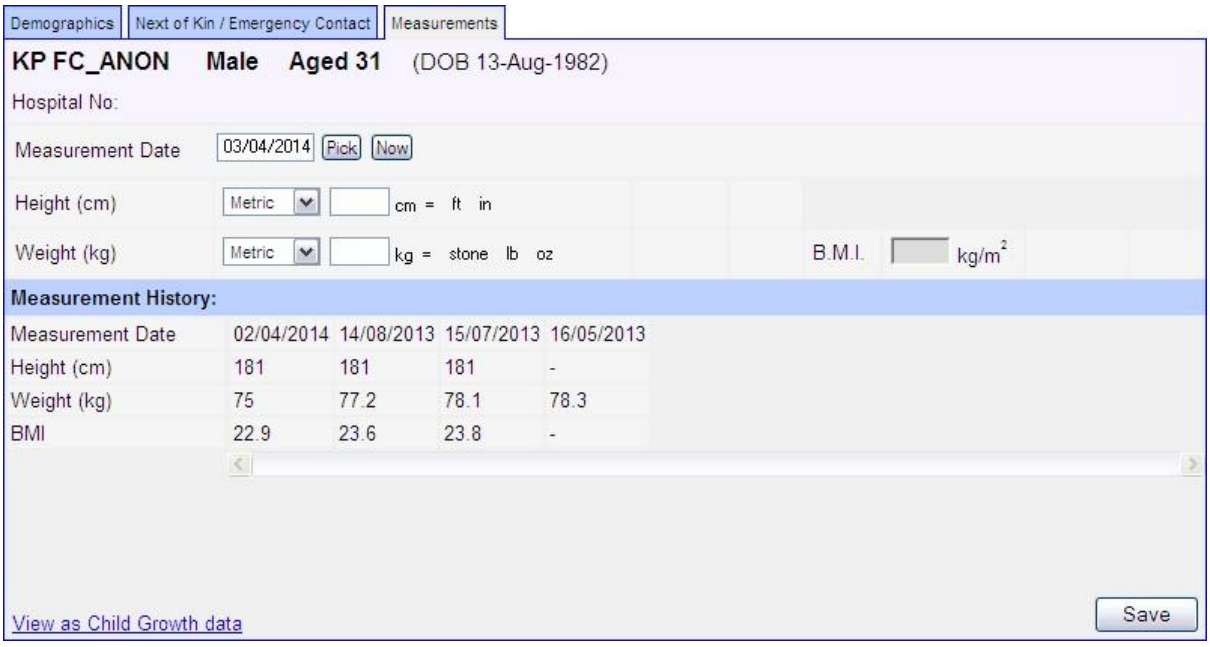

Figure 5. The common Height and Weight recording and history screen in the UHS EPR. The data would be available for any of the HICSS applications, including in outpatient clinics.

The Somerset Cancer Register (SCR) (2014)

By 2014, it had become apparent at UHS that the costs and administration needed to maintain compliance between the HICSS Cancer Module and the numerous nationally mandated data fields and reporting requirements made continuous maintenance and further upgrading of the HICSS module impractical. A decision was therefore made to purchase the nationally compliant Somerset Cancer Register (SCR) module. SCR (not to be confused in abbreviation with the Summary Care Record) is a system that was built and which has been maintained and upgraded by an NHS team who are based near Musgrave Park Hospital in Somerset. It is made available to all NHS cancer units at modest cost.

SCR was designed to meet all National Cancer Dataset Requirements, including The Cancer Outcomes Services Dataset; Cancer Waiting Times; Surgeon Level Reporting; and - National Clinical Audits, which include the NLCA (Lung); NOGCA (Oesophago-Gastric); NBCA (Bowel); NPCA (Prostate); SACT (Systemic Anti-Cancer Therapy Dataset) and HANA (Head & Neck) Audits. It also supports Quality Surveillance reporting.

By 2014, SCR had been purchased by more than 100 NHS Trusts, so it was regarded as the standard reporting system for nationally mandated cancer data. However, SCR was primarily an administrative reporting system, and it had not been optimised for daily clinical use. It was also demanding on the time and effort of the multidisciplinary team administrators and staff, who had manually to enter large volumes of data into the system in a somewhat inefficiently organised sequence of screens, menus and fields.

Alan Hales was commissioned by UHS to integrate SCR with a number of relevant UHS data feeds and into the UHS EPR in so far as was possible. However, the original SCR system remained primarily an administrative tool for the reporting of waiting times for diagnosis and treatment, rather than one which was optimised for the use of clinicians.

Alan and Ryan Beegan subsequently built a powerful adjunct to SCR in 2019, SCR Plus, which transformed the utility of SCR for clinical use. I describe this work in detail in another essay.

Developments in the UHS Digital Estate in 2015

An EPR Referral Interface was built to the Hospital's Computerised Radiology Information Solution, CRIS. CRIS manages alphanumeric data related to patient demographics, appointment details, billing, and clinical reports. CRIS is distinguished from a Picture Archiving and Communication System (PACS), which primarily handles digital medical images from various modalities, to optimise archiving, accessibility and share-ability.

The National 100K Genome Project was launched in 2015 to sequence the genomes of up to 100K patients with rare diseases or cancers. Recruitment was completed in December 2018. Research and analysis of the data set is ongoing. 100,000 genomes were ultimately sequenced from around 85,000 NHS patients. A team from the UHS IT service was seconded to the programme to develop supporting software for the project**.**

NHS Number and GP tracing: UHS adopted the InterSystems HealthShare Spine Mini Service Provider to accelerate NHS Number tracing and to improve the quality of patient data in early 2015. The trust sent more than 3,000 requests through the service each day.

UHS had previously relied on a weekly batch trace system to validate patient information against The Personal Demographics Service (PDS), which is the national master database of all NHS patients in England, Wales and the Isle of Man. previously patients were often admitted, treated and discharged before the data was returned.

Adrian Byrne's Thoughts on Patient Access to their Records (2015)

In July 2015, Adrian discussed patient access to clinical records in his Ade Memoire blog in the Digital Health Newsletter under the title **"ID, log-in, do stuff".** He asked:
"How do we make better information available to clinicians and share it? How do we provide better management data for population studies and the like? I want to consider the progress that has been made with patient online access to records in the acute sector.

I hope that we might develop a more joined up experience in the future, in which patients can use a single identity to access a number of interactive, cross sector, health services".

Our work in Southampton with Prostate Cancer UK

"Prostate Cancer UK is managing an international project called True NTH, which is funded by the Movember Foundation. It aims to improve "survivorship care" for men with prostate cancer. UHS has been commissioned to provide the IT support for prostate cancer patients from different cancer centres in virtual follow up. as part of the True NTH Programme, and in partnership with Prostate Cancer UK. This solution links the patient with their own hospital with a virtual clinic function to engage clinicians. It pushes data to a personal health record outside any of the services or systems.

In another strand, my colleague Amir Mehrkar, chief clinical information officer for the Hampshire Health Record project and the self-styled Robin Hood of information, aims to take from the information-rich and give it to the information-poor, so as to deliver better patient care through better information sharing across health and social care in Hampshire ".
(See https://www.digitalhealth.net/2014/07/loved-by-the-good/)

"The NHS England architecture folks and I have been talking about the possibility of a health identity. This would enable a GP to vouch once for a patient, who will then have access to a validated NHS Number [record]. The patient could then use the credentials to gain direct access to services and information sources offered at Southampton General [or other]. I'm quite excited about that ... The NHS Number is a great resource and this kind of linkage, I think, is a great way to use it".

Those Pesky Pace-Setters of Commerce

Adrian observed that *"The e-retailer, the on-line banker, and others have created all kinds of false perceptions. For example, your bank will email things to you so "why in the NHS can't we have email contact with patients"? However, a bank will only email you a link to a website where you must log-in. So, where do our new customers log-in to access NHS information and services? We need to keep focused on what we know will work for us.*

There are three components to a good online experience for patients:
- <u>Their credentials or identity</u> and how we vouch for those so that they can access a record attached to a validated NHS Number;

- An authentication service that they can then use to vouch for themselves against other trusted systems in a so called federated way so that they can access a GP system with the same log-in details [username/password] to they connect to an acute trust

- A Personal Health Record (PHR), which is a cloud based resource that will hold shared information entered by care professionals, the patient themselves, and an increasing array of wearable technologies.

Some or all of those functions may be provided by one vendor system but the separation of functions should in my view be recognised....If we are going to really transform the health system we need to be harnessing the power of the patient. Patient engagement is essential and you may have to work hard at it with a permanent communications lead.

Patients also need to be on a site doing something for themselves when you want them to do something for you. We see half a million outpatients a year, so getting a proportion of them to do some of the work is going to make a significant difference to your workload".

Developments in the UHS Digital Estate in 2016

In 2016, the Hyland OnBase Electronic Document Management System (EDMS) was acquired. I develop the story of OnBase and the evolved purpose of this system in a separate essay in this series.

The Launch of the UHS CHARTS Unitary EPR Interface (2016)

In parallel with the OnBase acquisition, the "Clinical Handover and Record of Treatment System"(CHARTS) was launched in the UHS Clinical Data Estate as a "one stop", single login system and wrapper for a portfolio of clinical data systems, which included EDocs, EQuest, HICSS Surgical Ops, SECTRA PACS, Clinic Worklists, Doctors Worklists and UHS Lifelines.

The UHS EPR Wrapper was launched in 2016 and named CHARTS. As the record of any patient is called up from the Patient Master Index, all of the systems which hold information on that patient and about his or her management are loaded immediately (Figures 6 and 7).

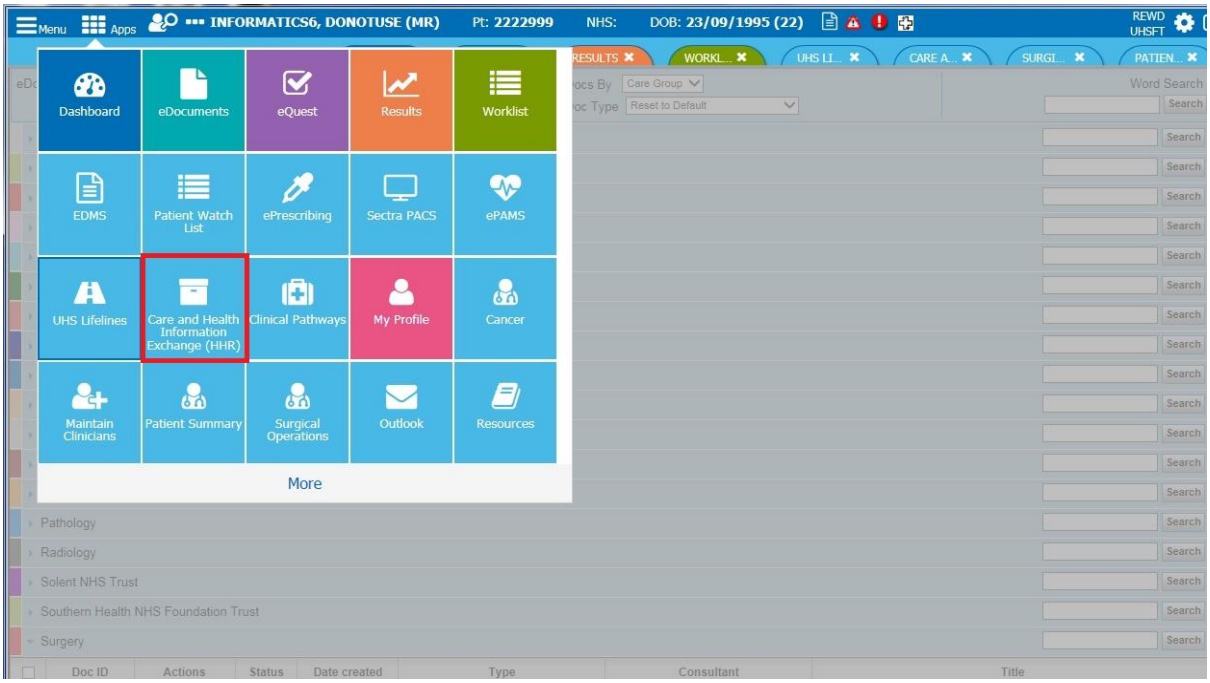

Figure 6. A screenshot of CHARTS, the UHS individual patient record wrapper, which accesses a number of component systems through single sign on, tabs and menus.

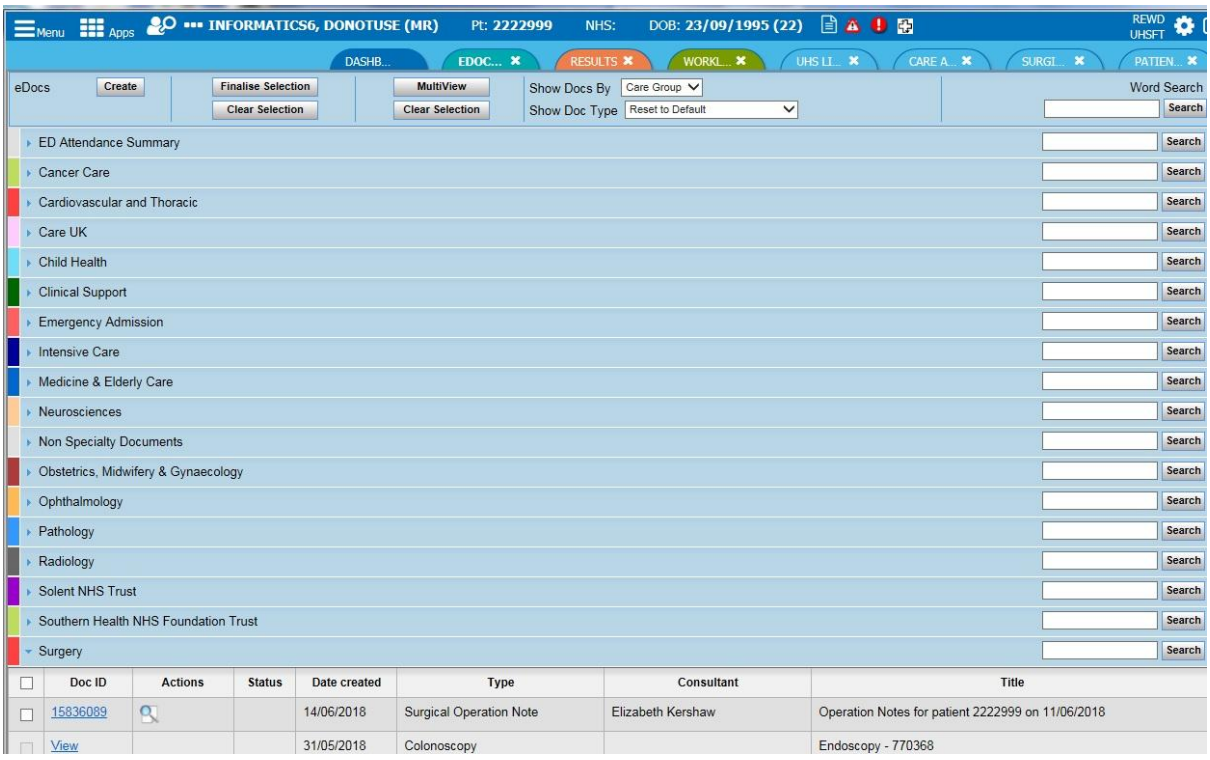

Figure 7. This is a screenshot of the UHS CHARTS EPR Wrapper, in which the eDocs system has been launched from within CHARTS for our universal test patient.

Towards an EPR interface with minimal redundancy for the end user.

Despite the introduction of the UHS CHARTS EPR Wrapper, the user still has to enter each of the subsystems to draw out the relevant information for any particular consultation or clinical intervention. The screenshot in Figure 7, in which the eDocs system has been opened for our test patient, exemplifies a persisting problem in the use of eDocs. The user still has to open each of the subsections to discover and open the individual documents, or to open the Results tab to obtain test results, for example.

This creates a significant time penalty in busy clinical use, and clinical risk from the likely failure to open document lists which are not directly related to the user's task (eg in a surgical clinic) but which may contain relevant or even critical details.

"One click access" to the entire record of any individual's EPR in a format which provided oversight and direct visualisation of all documents, reports and other critical information on a single interactive screen was the next step in the evolution of the EPR. This is the basis of the UHS Lifelines project which is described in much greater detail in subsequent essays.

Outpatient Clinic Worklists (2016) integrated the patient list for any one clinic from eCAMIS with CHARTS functionality, so that clinicians could work seamlessly through an outpatient clinic within the digital environment.

Inpatient Doctors Worklists (2016) were a similar concept for inpatient work. Prior to the development of Doctors Worklists (DW), it was common for junior hospital doctors to pass on information about individual patients between shifts using hand written notes. This was an imperfect process with high clinical risk. DW consolidated this process in a clinical log which is accessible at any time, anywhere by any user.

A Further Perspective in 2016 on NHS Apps

Adrian Byrne touched on the wider issue of information accessibility to patients in his essay *"ID, log-in, do stuff" in 2015.* The next logical step was to consider how patient access might be improved by personal Apps, such as has subsequently been realised with the NHS App.

On 15th March 2016, Adrian addressed the theme of Health Apps in his Ade Memoire Digital Health Blog on the subject of "Feeling App-athetic". He wrote that:
"... The NHS should be making more use of apps. The smart phone was invented around 2007. The iPad arrived in 2010. When will we get off the peak of inflated expectation for a health app and dive in? I can't wait.

Many Health Apps are disconnected from anything else, but health providers need to know who you are. A good comparison for health apps is banking. Banks need to know who I am, and to connect me with a reliable identity and record. As the customer, I am responsible for setting up my bank account; the bank keeps tabs on me within a one-to-one relationship.

The Rt Hon George Freeman recently talked about 'laying down the tracks' for a digital health service; he spoke about the different roles of the centre and local organisations in setting and enforcing standards and creating services to run over them. Presently, it seems as if enterprise Electronic Patient Records – our hospital and GP systems – are on one gauge; while consumer apps run on a selection of narrow gauges. In order for the tracks to join up, we need some standards...."

Connect it up

Adrian observed that *"Health is a complicated business, and the business associated with health is complicated, and the apps that run health systems are complicated. There are a seemingly unlimited number of parameters that can be presented to decision-making clinicians. It is clear that this data will come from increasingly diverse sources, including from patient held devices.*

We should therefore categorise health related App into Disconnected and Connected camps. The MicroGuide is a good example of a Disconnected App. It helps Hospitals, Health Boards and NHS Trusts to create, edit, and publish their own local guidance and policies, and to allow an organisation to upload policy documents for decision support. The Microguide was aimed at doctors prescribing antibiotics, but it doesn't let me log-in in patient context, or allow me to prescribe, or allow me to save any of this back to the patient record.

The myriad of health and well-being apps that could be better Connected will allow you to track steps, or manage your diabetes or other condition, but we don't yet have enough of these apps... From the consumer perspective, how do I know an app is safe to use? Will it be subject to a kite marking type system? The future is bright and the potential is enormous for Health Apps. However, we may not even be at base camp. Douglas Adams recognised the challenges to technical progress, in pronouncing that:

1. Anything that is in the world when you're born is normal and ordinary and is just a natural part of the way the world works.

2. Anything that's invented between when you're fifteen and thirty-five is new and exciting and revolutionary and you can probably get a career in it.

3. Anything invented after you're thirty-five is against the natural order of things...."

The Persisting Challenge of Full Digitisation of the EPR in 2016

Adrian subsequently reflected on the challenge for digital leaders of how best to set strategy for the design and implementation of user-optimised clinical data estates in another blog post on the Digital Health website in August 2016. He noted that there were still no established and optimal systems. The software environment was changing rapidly, as were the global architectures of the internet, wireless networking and commercial browsers. His key points were as follows:

"A year or so ago we learned that we had five years to achieve a digital, real time interoperable patient record with the publication by the UK Government of the policy paper "Personalised Health and Care 2020: Using Data and Technology to Transform Outcomes for Patients and Citizens: A Framework for Action".

see https://www.gov.uk/government/publications/personalised-health-and-care-2020

He asked: *"What needs to be achieved, and how long will it realistically take? Let's start in our hospitals, where the 'paperless' initiative is primarily aimed. The acute sector is far more demanding in the world of patient record systems than other sectors in health, in that:*

- It meets people who it does not know and who it has to match, track and code.

- It has to deal with a myriad of staff, including unfamiliar locums.

- These staff generate episodes of care 'episodes'.

- It has to group up these episodes and bill for them, while tracking morbidity data.

- It has to send and receive information from industrial scale partners, such as laboratories that deal with millions of samples per annum.
- It has to merge data from multiple specialties, from operating theatres and critical care. (my own hospital has more than a hundred different specialities in terms of IT modules).
- Then there's research…

While we are often told that the acute sector lags behind other health and industry sectors, there's no getting away from the fact that it's a massively complex environment. Hospitals have a lot of IT, but few would claim to have a comprehensive EPR. How long would it take to go out to market, find and buy one, get it in place, and get it working properly?"

The Challenges of Procurement of Computer Systems and Software

"People whinge about procurement. Sometimes, they blame the Official Journal of the European Union (OJEU) process, which mandates that all tenders from the public sector which are valued above a certain financial threshold according to EU legislation, must be published. They hope that buying through formal commercial frameworks will provide a shortcut. This is wrong, for two reasons:
Firstly, the procurement is not the rate limiting factor.
Secondly, it is nigh on impossible to adequately specify an EPR for a hospital within a framework that would adequately fit your organisation.

You can try and shorten the process, but in my experience it will take a minimum of around 18 months, with all ducks lined up, clinicians engaged and so forth, to specify and buy a hospital wide clinical system that users will actually buy into, which is absolutely critical. Moreover, it is likely that you will have more than one organisation involved, in which case you will shift from lining up ducks to waiting for planets to align in an eclipse.

You can try using a framework, but you might end up doing a lot of negotiation and change control when you are already over the proverbial barrel. Oh yes, and just when you think it's all over, and you have chosen your shiny new thing, you will be surprised at how long it will take to get that contract signed so that you can mobilise."

Build, implement, roll-out, train and support

"Then you have to build the system, interface it, implement it and roll it out. When we acquired e-Prescribing in Southampton, the actual implementation involved full on, 24×7 hand-holding support. That can be scaled down later, but on a current project that we are working on it has become clear that just to go-live on one ward will involve training over a hundred people. It will take around 18 months to roll-out this project. Moreover, you can't do too many things in parallel, from a user impact or a change control perspective.

When it comes to the core building blocks of an EPR, many hospitals have yet to introduce a satisfactory order communications system, and others have only secured a basic pathology ordering system. Meantime, relatively few hospitals have yet done e-prescribing. Does it feel already like time is running out on five years?"

Interoperability between EPR component systems

"Interoperability" is a word which now seems to be part of business speak, like "bandwidth". People now expect connectivity, which is hard, but strategists fail to focus on two underlying dependencies:

1. The data and systems must be interoperable;

2. There needs to be data to exchange within the EPR.

We run one of the more successful interoperability systems in the Hampshire Health Record. We also run an imaging consortium and a sharing environment which is based on XDS. Even so, I think of our solution as interoperability version 1.0 and we need to move to version 2.0; to more effectively join up health and care organisations.

(Editorial note: XDS, Extensible Discovery Service, is a communication protocol for managing service discovery and dynamic configuration in a micro-services architecture).

Adrian continued on observing that *"The Bristol Connecting Care programme has been heavily engaged in templating some best practice around interoperability. Their system went live across Bristol, North Somerset and South Gloucestershire in December 2013. It shares real-time patient data between GPs, community providers, local authorities and three acute trusts via an Orion Health portal). Nevertheless, to get to point which Hampshire, Bristol and*

some other organisations have already reached will take considerable time and work for many other groups."

Where will we be with EPR Development in 2020?

"We often hear debates about the benefits of large (or single system) EPRs and small (or best of breed) implementations, and about open source versus closed source solutions. In Southampton we have been on the same path for a web-based, integrated platform for more than 15 years. So, given the five year timeframes to achieve the "interoperable" real time record, it is pretty clear that time is running short for latecomers to the game, and regardless of your philosophy of popular large megasuite software systems versus the small interfaced system approach which we have championed.

We now have another layer of uncertainty in the national financial 'reset'... And then there's the Brexit factor. ... We are very resourceful in NHS informatics, despite our poor reputation in some circles for being steam driven. Just look at what we achieve for about 1-1.5% of our organisation's spending. I must therefore remain optimistic ..
https://www.digitalhealth.net/2016/08/ade-memoire-how-long/

The Hyland OnBase Electronic Document Management System (2016)

In 2014, a decision was made at UHS to acquire an electronic document management system (EDMS) which would capture the huge volumes of paper documents in our archival stores and which were still being generated on a daily basis on the wards, in the clinics and through emergency admissions.

The project was put out to competitive tender and awarded to The Hyland Corporation of Cleveland Ohio, whose adaptable OnBase enterprise software system was well established in a range of commercial (non-health) applications.

It was initially foreseen that OnBase would supplant our in house EPR and CHARTS as the system matured, but it became progressively more apparent that the OnBase team had overpromised and that it would not replicate or deliver the usability that we had now forged

in CHARTS, with eDocs, eQuest, UHS Lifelines and the various other locally developed and integrated commercial systems.

It eventually became evident that CHARTS should continue as our primary EPR, and that OnBase should be retained as an e-filing cabinet for the deep storage and retrieval of secondary documents, while eDocs would continue as the primary document management system.

Important lessons of broad generalisability were learned from this project, and I have recorded this important element of UHS digital history in a separate essay in this series.

By 2018, the medium term futures of both CHARTS and OnBase were assured in a mutually supporting role. Regrettably, the bespoke design of OnBase continued to confound easy and fast interoperability, design harmonisation and user satisfaction for a number of years.

The Global Digital Exemplar Award to UHS in 2016

UHS was designated a Global Digital Exemplar (GDE), or Centre of Digital Excellence, in September 2016. This was announced by then-Health Secretary Jeremy Hunt at the NHS Health and Care Innovation Expo in Manchester. UHS was one of 12 acute trusts to be awarded this status. UHS received £10 million in funding over four years to fast-track digital transformation and establish "blueprints" for other NHS trusts to follow. UHS partnered with Hampshire Hospitals NHS Foundation Trust as its "fast follower".

This UK Government initiative was one consequence of the report by Dr Robert Wachter on Making IT Work Making IT work: harnessing the power of health information technology to improve care in England **for** the National Advisory Group on Health Information Technology.

Developments in the UHS Digital Estate in 2017

The Regional Genomics portal and the Southampton Intergene Project .

The Genomics England Research Environment was established in 2012 with funding from the Medical Research Council to create a UK-wide Infrastructure for Large-scale Clinical Genomics Research. The 100,000 Genomes Project was Genomics England's first initiative, to sequence 100,000 genomes from around 85,000 NHS patients with cancers.

An IT team at UHS was charged with the co-development of a portal for Genomics England which would help allow users to interact with the national system. This project was not directly related to the UHS UPR, but the work of the UHS IT team was reportedly well regarded nationally.

Intergene was developed as a system to support the national 100K Genome project. Adrian Byrne recalls that *"Our principle was (as usual) to try not to support the development of stand alone systems. Intergene was our attempt to simplify the uploading of data without unnecessary duplication, and to distribute back to the relevant users through our EPR. We did it successfully, but the national programme leads then chose a different set of steps and products".*

Figure 8: marketing screenshot of the Sample 360 APP on a hand held device

Sample 360 (MSoft 360, Bromborough UK) (2017)

Sample360 was a commercial digital collection system for the safe tracking of blood test samples. It receives electronic orders directly from the main Hospital Systems, including the EPR and the Laboratory Information System (LIS). Orders are downloaded to a mobile device for the phlebotomist. Positive Patient ID is performed at the bedside using Barcodes and Radio Frequency Identification (RFID) technology, thus substantially reducing error rates.

It helpfully prints sample tube labels with a barcode at the bedside. This allows the sample tube to be loaded directly onto the analyser when it reaches the laboratory. Features also include sample tracking in transit using GPS; Real-time temperature tracking; automatic "booking in" of transport containers (eg coolboxes) to the Lab; Real-time updates of Sample to requesting staff; Elimination of incidents of the wrong blood in the sample tube, and huge efficiency gains in laboratories through automation, as samples no longer need to be re-labelled before analysis.

Patient Task Lists in Charts (2017).

The Task List displays all tasks which can be performed for selected patients in the selected situation. The task list can serve as a simple navigation tool to toggle from one function to the next, and as a control instrument for cooperative work between various occupational groups.

The UHS Whiteboard and Electronic Bed Management System (2017)

For generations, hospital wards have managed patients and bed allocations on blackboards or whiteboards which are often prominently displayed near the nursing station. The Trust recognised the need to improve on this manual system with a digital system which linked the bed status of every bed and occupant in real time to central reporting systems, so that patients could be found and tracked throughout the hospital by the bed managers.

In 2017, UHS tasked Alan Hales to develop a bespoke digital patient tracking system. The large touch screen "Whiteboard" prominently displays information from the patient's electronic record, including his or her name and bed placement on the ward.

The opportunity was also taken to display clinical alerts to include co-morbidities, length of admission and the predicted discharge date. This information was encoded in symbols to minimise untoward breaches of confidentiality in the presence of ward visitors.

The system substantially improved the efficiency of bed management and of information flow around the hospital, including an unexpected side effect of improving clinical noting.

The 2017 proposal to re-purchase CHARTS from EMIS Health

One constraint upon the further development of the CHARTS EPR in house was the fact that the Intellectual Property of key elements, including eDocs and eQuest, was owned by EMIS Health. This was in consequence of a convoluted series of transactions through which Alan Hales, as the developer of the systems through his company Scorpio Information Systems, had sold on the IP to Ascribe Software Ltd, which had subsequently sold on to EMIS Health.

EMIS was primarily interested in GP and other applications, such that the UHS systems were being maintained by a small development team who were based at the Chilworth Science Park outside Southampton. EMIS was not promoting the CHARTS product suite to other hospitals, and there was no reference to CHARTS, eDocs, eQuest, DWL or HICSS on the EMIS website. It was thus reportedly costing the Trust a very substantial amount of money in license and upgrade costs to pay the EMIS programming team to do the bespoke development work which EMIS seemingly had no intention of capitalising upon or marketing outwith UHS, and which had originally been developed in house at UHS in any case.

The success of the recent launch of CHARTS suggested a way forwards through which UHS could secure its future through a buy back from EMIS. With ownership of CHARTS, the Trust could more efficiently:

- improve its functionality in an agile manner with greater end user engagement in the design phase; reduce its lifetime costs; - improve end user productivity across the Trust; and provide a marketable product under UHS ownership.
- Secure the services of the Chilworth based EMIS coding team in house.
- Update the design and functionality in CHARTS without EMIS as the “middle man”.

The Hampshire Care and Health Information Exchange (CHIE) (2017)

For most citizens, most of the time, healthcare is triangulated between them, their GPs, and local Hospitals. Patients with more complex needs may travel to out-of-area specialist centres for further treatment, and geographically mobile patients may distribute their clinical attendances across many providers in the UK and beyond.

The Hampshire Health Record was renamed The Hampshire Care and Health Information Exchange (CHIE) in 2017 to reflect its expanding role and user base. It subsequently passed to the management of Orion Health in 2021, with a plan to make it interoperable withe the Dorset Care Record as the Wessex Care Record.

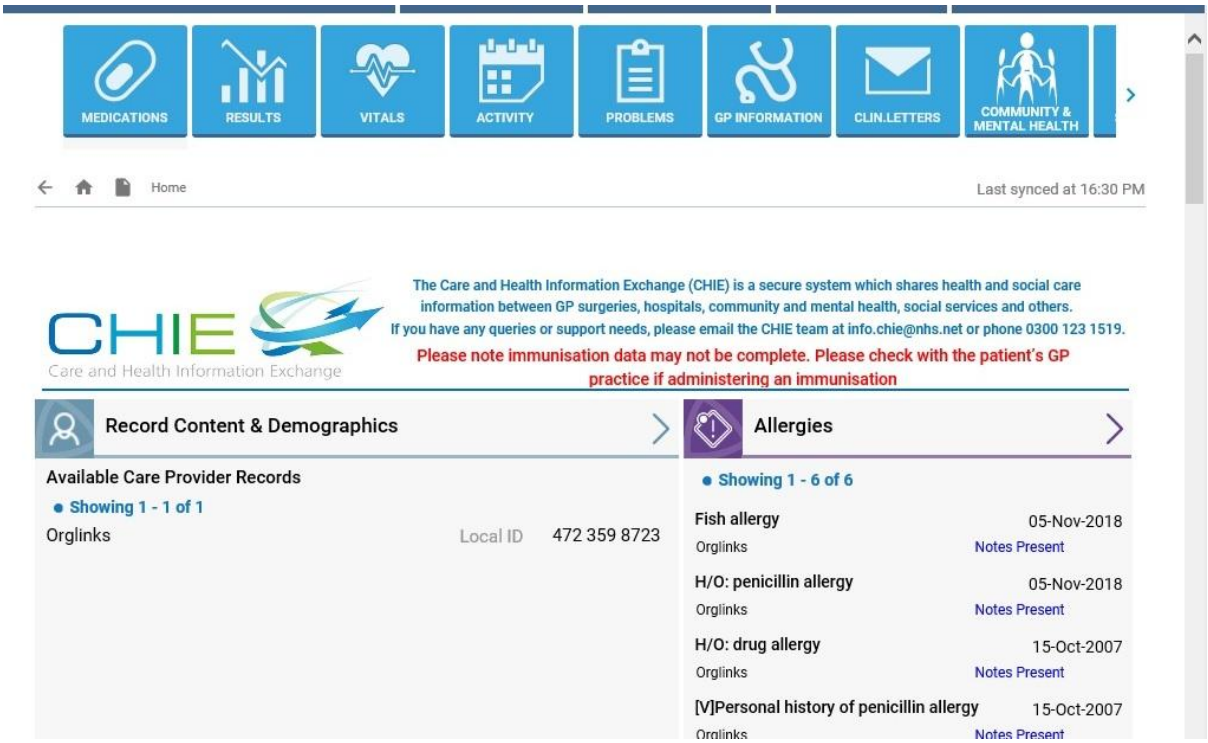

Figure 9: A screenshot of the CHIE record of a de-identified patient, as accessed and opened via the UHS CHARTS EPR wrapper in 2018.

CHIE was made accessible as an App from within CHARTS soon after its launch and in its original formatting, such that content from UHS systems such as correspondence with GPS is duplicated in both systems. Nevertheless, CHIE is very helpful in accessing information that was generated in other hospitals and organisations across the consortium to improve clinical efficiency.

Developments across the UHS Digital Estate in 2018

The Hyland OnBase Electronic Document Management System (EDMS) went live in 2018. I address the story of the EDMS in detail a separate essay.

DigiRounds was launched. DigiRounds was conceived by Dr Matthew Cordingley as a hand-held system to simplify the work of doctors on ward rounds and to eliminate paper charts by direct communication with the EPR, using Apple iPads as the primary "end of the bed" tool. Matt reports that:

"We did *not wish to include any unnecessary information, icons or images in Digirounds. We set a maximum of seven tabs on the screen to focus the user. We sought to replicate the look and feel of a traditional paper observation chart. The same approach was applied to the fluid charts."*

The CHARTS Outpatients Module (2018)

Adrian Byrne recalls that the CHARTS Outpatients Module was the key to going paperless in Outpatient Department (OPD). It integrated the usual PAS information with clinical noting, historic documents, the ordering of tests and the recording of clinic outcomes. It linked to the Hampshire CHIE, and underwrote a Virtual Outpatients function which saw particular use during the Covid Pandemic.

2018: PAS and pathology – the problem with old systems

In January 2018, Adrian wrote in his Ade Memoire Digital Health Blog about the problem of funding and reorganising software acquisitions to support smoother revenue streams and to mitigate the problems of software with a finite life span. He wrote that:

"Many hospitals will have two legacy systems at the core of their IT.

One is a Patient Administration System (PAS) to collect the NHS data that arose out of the work of Edith Körner in the 1980s.

The PAS has adapted to coding of the data for clinical and finance purposes; to run reporting solutions for analysis; and to accommodate the needs of departmental systems such as the Emergency Department (ED).

The other is a Pathology IT system that arose out of laboratory needs with analysers...Both of these systems have in fact outgrown themselves for similar reasons....

Pathology teams needed to do more than just report the level of serum rhubarb in a bottle of blood, so their systems adapted to include a patient index for delta checking and clinical reporting, which would otherwise be done in PAS systems.

The problem of legacy software is exacerbated because we never seem to renew anything. The default position is to keep bolting things on, which suppresses market innovation".

Is it time for new PAS and Pathology Systems?

Adrian asked *"what would these systems be like if they were designed today? A PAS is fundamentally a scheduler. Nothing in this functionality would specifically need to be about health. We would schedule everything from staff, buildings and equipment through clinics and patients. We would put the data into a warehouse for reporting and we would add the coding to have a rich platform for business intelligence, adding in other data for clinical decision support...*

The Pathology system would manage a lab full of equipment dealing with a high throughput but it would not need to know anything about the patients, as clinicians could refer to the EPR. It would then also be much easier to implement Lord Carter's 2015 Report model for HMG on NHS productivity, which foresaw factory style centralised labs rather than distributed systems using open platforms..."
(see https://www.gov.uk/government/publications/productivity-in-nhs-hospitals)

Software as a Service: The Deconstruction of PAS and Pathology Systems

Adrian further noted that *"We have been thinking about the deconstruction of these systems, and to challenge the commercial marketplace for clinical software, rather than hanging on to old systems for too long. We may need to turn all software into a revenue service. It has been too easy for people to make perpetual savings once a capital product has fully depreciated. It still works, so why invest in replacing it?*

We need to keep the level of investment constant, and ensure that the platform is open so that we can change from one service to another at the end of the contract, or run multiple pieces of the jigsaw as separate services on the platform.

This will require a new approach from finance from top to bottom. We can see a looming problem with Microsoft around 2020 when our licences for MS Office terminate. The same problem must also be addressed for all clinical and administrative software. The market must also allow for the fact that the revenue is more assured; in other words, suppliers should not just receive a windfall on this.

Centrally, there continues to be a tendency to provide Public Dividend Capital (PDC) for initiatives where apart from the initial project costs, the overall "asset" is an ongoing revenue spend and service. This is also getting more difficult... we need a bit of imagination on how to move ahead."
https://www.digitalhealth.net/2018/01/pas-and-pathology-the-problem-with-old-systems/

Developments of the UHS Clinical Digital Estate during 2019

2019 was broadly a year of consolidation with the various recent acquisitions and changes.

The concept of **Closed Loop Service Referrals** was developed to minimise the residual use of paper for service requests and clinical referrals. These were notoriously unreliable and patients could get lost in the system with failure to follow up intended actions.

Software tools for Referral Grading, Treatment Sequencing and the Real Time Validation of Waiting Lists were related functions which became invaluable during the pandemic. We had to know we were treating people with clinical priority.

The EMIS Symphony system was provided to the Eye Emergency Department.

The Enhanced Somerset Cancer Register Module (SCR+) was developed. I cover this very important development for cancer services at UHS in a separate series of essays.

Developments of the UHS Clinical Digital Estate during in 2020

The Covid Pandemic reached the UK in mid March 2020. It mandated a series of urgent upgrades to the hospital software systems to address the needs for patient safety and clinical prioritisation, and to manage staff and patient testing. The IT team dispersed to their homes or to support Covid testing projects, and momentum on the EPR program slowed.

We made a modest contribution by upgrading UHS Lifelines to display the hospital derived Covid test results which were linked to eQuest. Alan Hales kindly added a “Covid timeline” to the interface on which covid tests were displayed as a 12 x 12 pixel spiky “viral” icon, which would be green if the test was negative and red if it was positive (Figure 10). This was a particularly helpful visual reference tool in outpatient clinics, in relating clinical status and outcomes to the impact of the virus as the pandemic dragged on.

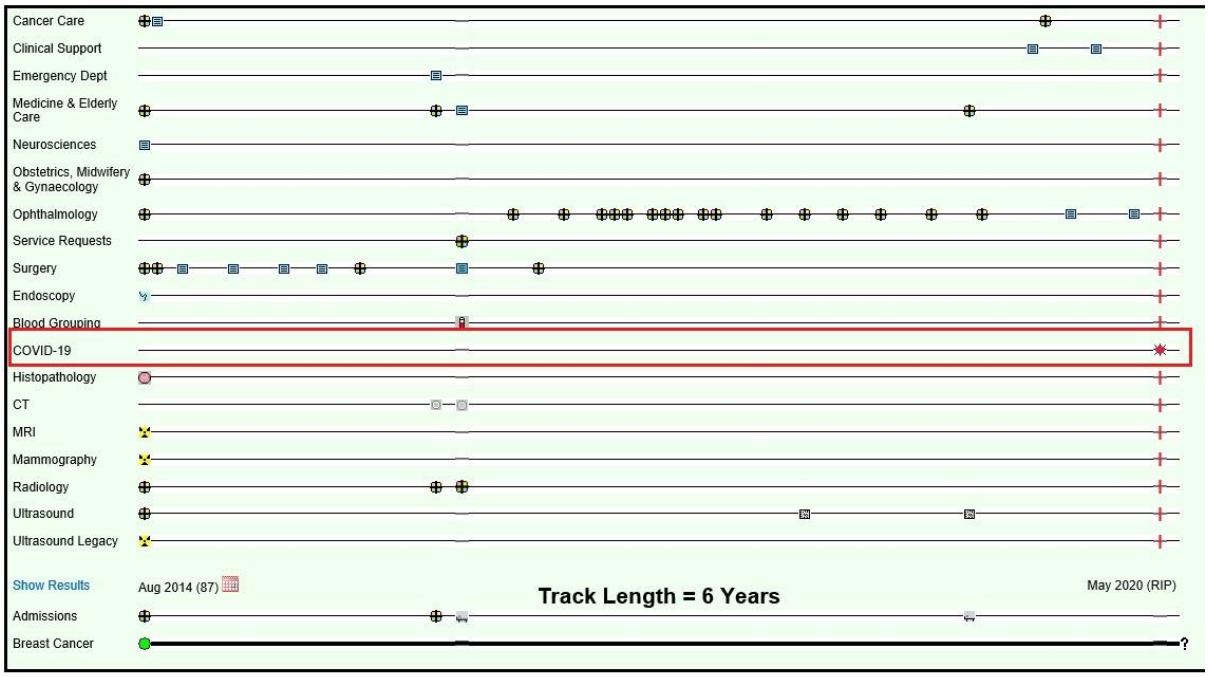

Figure 10: This screenshot of the UHS Lifelines interface record of an 89 year old lady who died in the hospital of a covid infection in May 2020

The Re-purchase from EMIS Health of the IP to CHARTS and the HICSS Endoscopy was completed. at which point the Chilworth Science Park based team were re-engaged by UHS, along with the commercial obligations and opportunities of the HICSS Endoscopy system.

The electronic eTCI ("To Come In") surgical admissions module was launched in CHARTS for this listing and administrative management of patients for surgical and invasive procedures, from the point of clinical decision, through the operating list planning stage to the hospital admission. This replaced an inefficient card index system.

A new **Electronic Discharge Summary** was released during to accommodate a range of national requirements which had been developed with input from the Royal College of Physicians.

The Badgernet Maternity system: (System C) was launched in 2020.
Badgernet is a national and centrally hosted system which links all maternity units in the UK, thus ensuring that records can be accessed and updated in any unit in a standard format.
Adrian Byrne recalls that the Badgernet acquisition was an interesting story, in that.
UHS had an integrated maternity module and we wanted to bring in other local hospital maternity units to plug into the MyMedicalRecord application. The other hospitals wanted to buy a commercial system so we had to give in. I protested to no avail.

They implemented the new system as separate instances, so there is still no single view of a patient who moves between hospitals (for example between Winchester and Southampton), and at UHS we lost the integration of the maternity system with the rest of the hospital EPR. Moreover, the client facing side of the system lacks the all encompassing strategy of MyMedicalRecord, so it has effectively become another stand alone application over a wide area. I think the national strategists went backwards with this project".

Developments in 2021
The Covid pandemic persisted into and through 2021, and IT staff remained dispersed and largely working from home. There were modest developments in a range of systems to improve the EPR, including:
Task Management enhancements to CHARTS
Changes in eQuest to support new Laboratory Information Management System (LIMS)

Integration of the 3M M-modal Speech recognition system into eDocs in 2021

This was a major step forwards for secretarial and administrative productivity Traditionally, clinicians had dictated correspondence into Dictaphones. At some later time, and often weeks later, the dictations were transcribed into documents in eDocs. These were then returned to the originators for proof reading and sign off, by which time the memory of the original case and of the circumstances of dictating the letter may well have faded.

By 2021, the standard of voice recognition had advanced to the degree that most voices and accents could be recognised to the level at which text could be dictated directly onto the computer screen and read in near real time with a high degree of accuracy, other than for names, with which the system struggled and scrambled.

Moreover, the dictation was done directly into the appropriate template for the appropriate patient using the system. Dictation and spelling errors could be corrected in real time. On conclusion of the dictation, the user has the option either to leave the dictation in draft, as might be the case if further test results are awaited, or to send the letter directly to the recipient, thus bypassing many of the delays of the previous system.

There is a modest immediate time penalty for the user in dictating the letter during a clinic, but this is offset by the huge operational savings in secretarial time and direct electronic communication with the intended recipient. The system has since been expanded to a wider range of uses, including direct text entry for annotation of events, as on ward rounds; and to improve accessibility and navigation around Trust data systems.

Integration of the Data Warehouse and Business Intelligence Systems, 2021

The Microsoft Power Business Intelligence (BI) system was acquired by UHS to provide analytics capabilities to information feeds from a wide range of devices, clinical resources, operational activity, finance, estates and workforce data, with a range of output formats, including dashboards, graphical tools, modelling, statistics and data modelling. Such analytics has a range of practical applications, as for example in understanding bed occupancy and management, and emergency department activity (Figure 11)

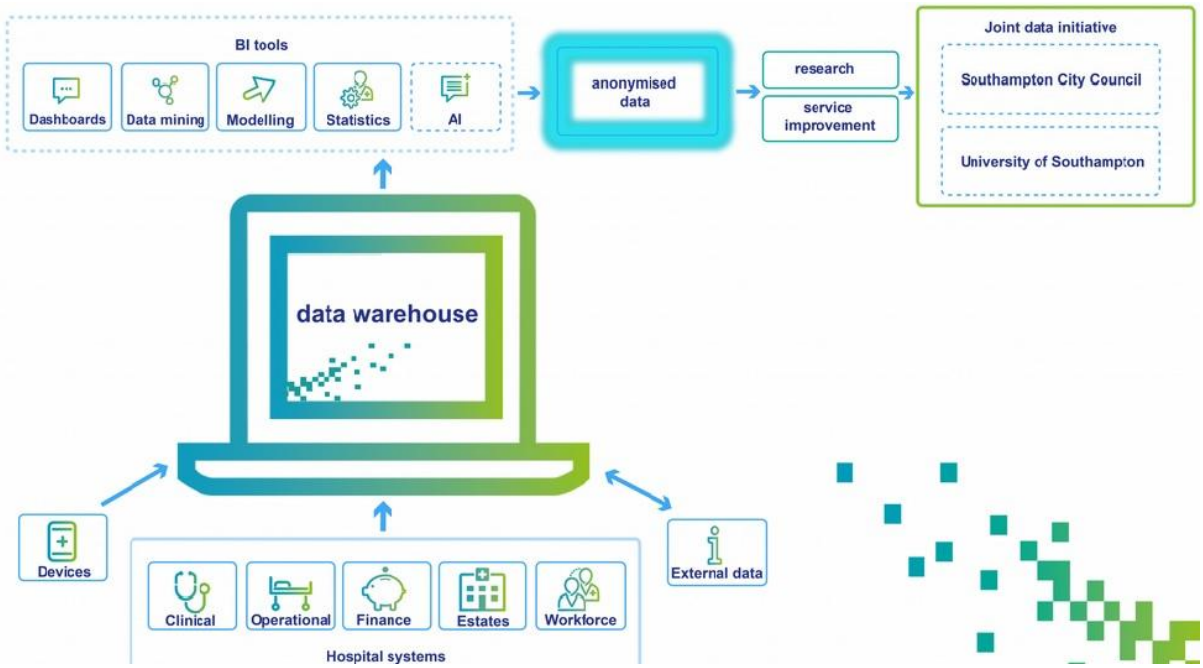

Figure 11: General schema of the use of a data warehouse and business intelligence tools at University Hospital Southampton from 2021 onwards (Image courtesy of UHS Digital)

Of particular interest was the proposal that the data from this system will also be linked to a local academic initiative named the Social Data Foundation for Health and Social Care (SDF), in partnership with Southampton City Council (SCC) and the Web Science Institute of the University of Southampton (UoS). (see www.socialdatafoundation.org).The first task of this project was to explore models of data trust in the movement of such data between disparate organisations (see Boniface et al https://eprints.soton.ac.uk/449699/). As of early2026, the outcomes of this programme are unclear.

Essay Summary

In this essay, I have reviewed the principal themes in the development of the Clinical Data Estate and the Electronic Patient Record at University Hospital Southampton over the decade of 2010-2021. Adrian Byrne has provided invaluable in depth insights into the scope and scale of the digital organisational challenges upon which he reflected for a national professional readership during this period of rapid technical and operational evolution.

Over this time, the elements of the EPR were integrated into the CHARTS EPR, and a number of other processes were introduced to improve the productivity and efficiency of the clinical and administrative workforces.

In subsequent essays, I will explore in greater detail the development of a number of contributory systems, including the Oracle APEX portfolio of systems; the OnBase Electronic Document Management System; the UHS Lifelines Integrative EPR Interface; the Southampton Breast Cancer Data System; and the Enhanced Somerset Cancer Register module which transformed the cancer multidisciplinary team process.

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Rew, DA (2026) *A History of Healthcare Computing and Advances in Clinical Information Productivity in Southampton, 1980 -2024:*
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Rew, DA (2026) *A history of healthcare computing and advances in clinical information productivity in Southampton, 1980 -2024:*
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