21.

The Use of a Paperless Clinical Results Reporting System A Hospital Case Study

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Introduction

New Zealand is a long way away and is a country about the same size as Great Britain, but with a population just short of 4 million people. Nearly 10% of those live within the area that my hospital and health service looks after. The city of Auckland has a total population of about 1.2 million. The Counties-Manukau District Health Board (CMDHB) provides secondary health care services to a population of 350,000 people in South Auckland, New Zealand. Its main facility is Middlemore Hospital, an 850-bed secondary and tertiary hospital that has been in existence for more than 50 years and is associated with the University of Auckland as a teaching hospital. (Its main claim to international haematology fame is Hb Manukau, a very unstable β-chain variant described in the British Journal of Haematology about ten years ago).

The hospital (**figure 1a**) provides care at secondary level for most conditions and there are tertiary centres for orthopaedics and plastic surgery and a national burns unit. There is an attached but separately identifiable children's hospital (**figure 1b**) and a number of out reach outpatient clinics. The largest of these is the Manakau SuperClinic (**figure 1c**) to which is attached an elective surgical unit of around 80 beds. This is the catchment served by the Middlemore Hospital laboratory. There are, in the region, about 400 general practitioners, many of whom work part-time, so there will be approximately 250 full-time equivalents. However, since the New Zealand health system has a separate community laboratory system directly funded on a fee for service basis from the government for processing general practitioner referred tests, our hospital laboratory has very little to do with specimens from those practitioners. The community laboratory also processes many tests from our outpatient clinics. At this point it should be stated that in South Auckland there is a relatively impoverished population comprising 15% New Zealand Maori and about 15% other Polynesians who have emigrated to Auckland. There are 80 of New Zealand's 200 socio-economically most deprived schools within the region, so there is a disproportionate concentration of deprivation.

Figure 1
(A) Middlemore Hospital;
(B) KidzFirst Hospital;
(C) Manukau SuperClinic.

The Old System

By 1997 it was apparent that the administrative arrangements for delivering reports to responsible clinicians, ensuring that appropriate action was taken on the reports and filing them in the patient's case records were failing. There was a rule in the hospital, perhaps unique to New Zealand, that no paper report could be filed in the patient's case notes until a medical officer had initialled it. That was so that significant results would be noticed and appropriate action taken. This meant that a laboratory request form would be written out, the request would be entered into the laboratory computer system, processed within the laboratory and the report printed. The reports had then to be sorted within the laboratory according to their ultimate destination, delivered by the mailman, sorted once more in the ward according to which team was caring for the patient, signed by a responsible clinician and then filed.

In many cases, the doctors found it easier to phone the laboratory and ask what the result was, than to search for the paper report. As a result the report was never signed and could not be filed. These are not practices and problems unique

to Middlemore Hospital but exist in hospitals worldwide. Again worldwide, laboratory technologists may put up barriers to make telephone enquiries more difficult. They may refuse to accept incoming telephone calls. Anyone wishing to speak to a technologist is required to call a pager number and leave a telephone extension number to which the call would be returned at some time in the future.

The resulting problem in the medical records department was the accumulation of large cartons of unfiled patient reports. These were reports that had circulated around in the hospital mail system for days, weeks or months awaiting a responsible medical signature prior to filing in the case record. By the eventual time of signing, the patient case record itself had been filed and there was not the manpower to find those folders and paste the results into them. Since this was becoming a gross clinical risk, changes had to be made.

The New System

A complete hospital information system is extremely expensive, costing, in our terms, $NZ15 million (about 7.5 million Euros). Further investigation produced a results repository system developed by SYSMEX DELPHIC, an Auckland-based company that began by producing laboratory information systems. What is being described here is not a laboratory information system; it is a report repository and its acronym ECLAIR stands for 'Electronic Clinical Information Repository'. ECLAIR is a suite of products that allows immediate and secure electronic access to patient clinical results and records. It is an electronic medical record (EMR) or clinical data repository (CDR). The system is fully scalable from small clinic to large multiple site institution. Based on a central data repository with access from multiple locations, ECLAIR fits well into a multiple hospital environment and, therefore, clinical observations from multiple hospitals can be stored in one database.

One can search for information by inserting the patient's ID into the box indicated and calling up a result (**figure 2a**). The results for this patient are then shown in a window (**figure 2b**). In this example the CBC is displayed and results outside the reference range are displayed in red. This display also indicates the laboratory performing the analysis, in this case the South Auckland Health Laboratory denoted by the acronym SAH in blue.

Reports are produced using standard protocols. In New Zealand, a National Health Index was defined about 15 or 20 years ago and every patient has an identifier of 3 letters and 4 digits. Conceptually this is a good thing, but, for the less than 4 million population of New Zealand there have been about ten and a half million National Health Indices issued. Following much effort by the Ministry of Health in Wellington, the number of currently issued National Health Indices is now about six and a half million. There thus remain problems with individual patients having more than one identifier.

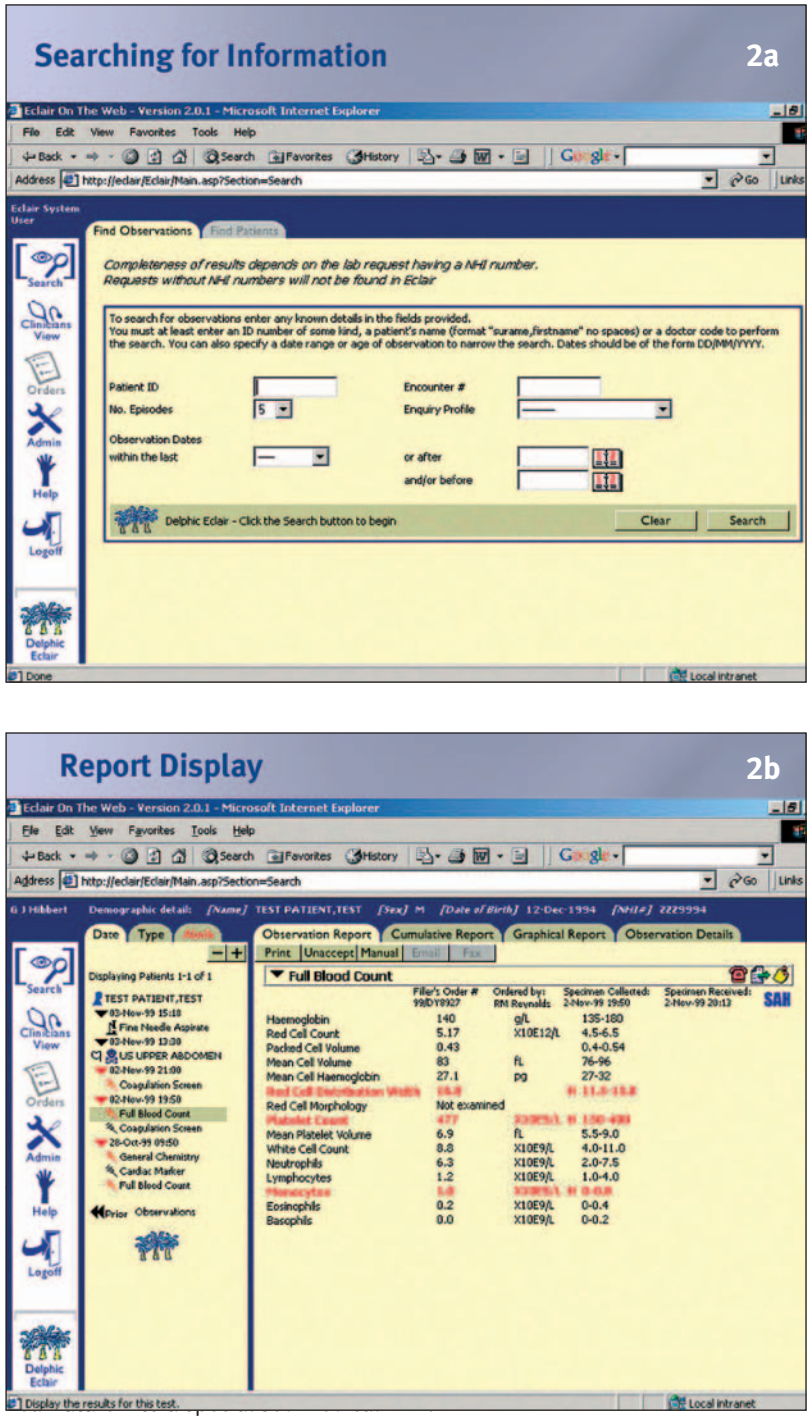

Figure 2
ÉCLAIR on the Web: searching for information (a) insert Patient ID; (b) CBC results display

Professor Van Hoof has already mentioned LOINC (Logical Observation Identifies, Names and Codes), the observation, organism and procedure coding) necessary to accumulate results coming from different laboratories. If results are to be accumulated, the system must know, for example, that haemoglobin measured in one

laboratory is comparable to that measured in another laboratory. Equally, the system must be aware when the results are not comparable, e.g. troponin assays. For this assay, companies produce kits for different analytes employing different assay principles and with different reference ranges. It would be dangerously inappropriate to accumulate those results across the same line and mislead a clinician that they were the same test.

ECLAIR is capable of delivering results including images from diverse types of diagnostic departments. Not only does it allow graphical display of selected results (**figure 3a**), it is capable of linking to a Picture Archive Computer System (PACS) or digital radiology system, so that by clicking on a link within a radiology report, a display of the relevant image appears (**figure 3b**) and similarly for histology (**figure 3c**). Clicking on the name of a test, links into the laboratory handbook to describe the features of that test (**figure 4**).

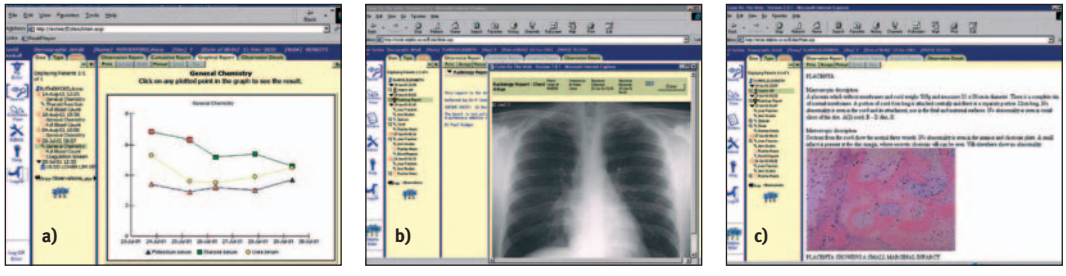

Figure 3
Graphical displays:
(a) serial chemistry results;
(b) radiology image;
(c) histology image plus report.

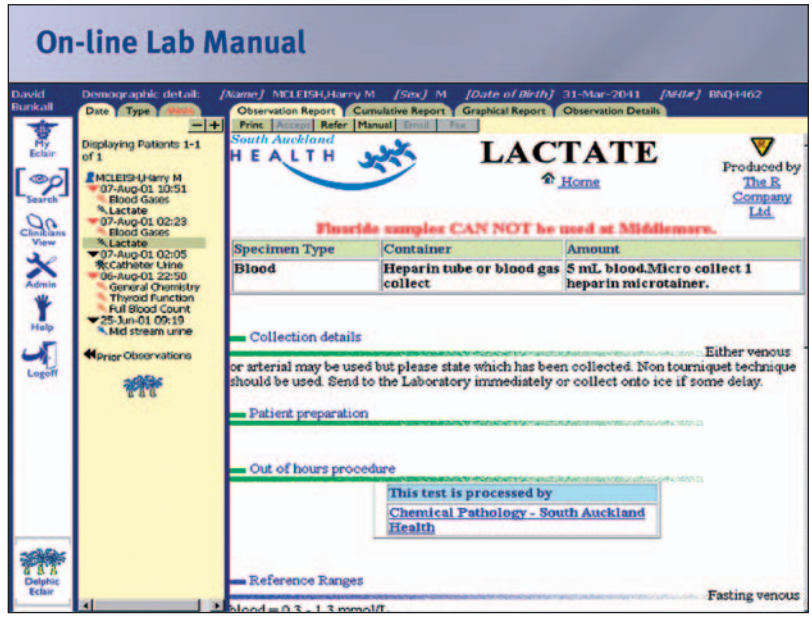

Figure 4
Link to Laboratory Handbook. The on-line laboratory manual.

Implementation problems and their solution

One of the first problems encountered was that the hospital information system worked according to a rule specifying that every encounter with a patient must have a responsible clinician who was a consultant. The report belonging to that encounter should then be directed back to that consultant, because he/she is responsible for the encounter. The system was so configured that an identifier could be inserted indicating that a particular system user wished to search for results for patients under the care of a particular consultant, which are clearly designated as 'unaccepted' (**figure 5a**). On display there is the facility to accept the result (**figure 5b**). This identifies the individual who accepts the result and remains as an annotation on that report in the system forever (**figure 5c**). That is the equivalent of the paper initial, except that the initial on the piece of paper used to be essentially anonymous but now it is simple to identify who has accepted responsibility for this report. This was quite threatening to clinicians, at least initially.

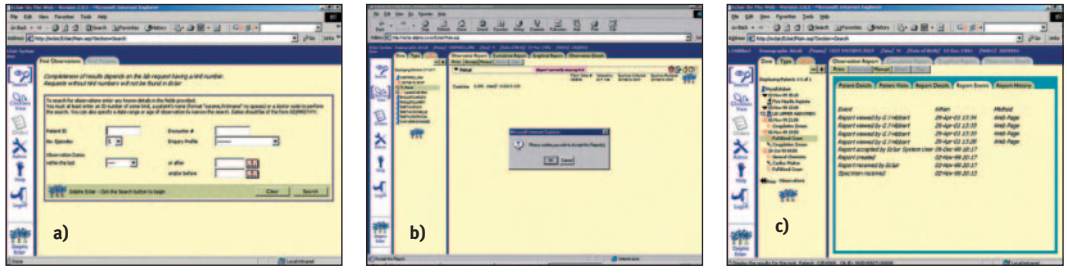

Figure 5
Accepting a laboratory result:
(a) the unaccepted r3sult display;
(b) facility to accept;
(c) permanent record of the individual accepting the result.

In many ways sending reports into the system and displaying them was the easy bit. The difficulty has been in solving the problems relating to the electronic report sign-off. First, it was a technical challenge because ECLAIR must interface with the hospital administration system in order to know who is responsible for a given report. Secondly the clinical process had to change; people had to get used to looking for results on a computer screen and accepting responsibility for them. We made some gross mistakes there. One of the first mistakes was that the Chief Medical Officer for the hospital let it be known that when undertaking Consultants' annual salary review, one of the things he would take into account was whether or not they were up to date with the acceptance of reports for patients under their care. This very nearly provoked a riot.

Next there was a problem with the hospital business rules because we discovered that there were many reports coming into the system owned by people who were not allowed to own them. It was discovered that clinics had been set up for diabetes nurse specialists. It was discovered that the orthopaedic fracture clinics, which are generally run by registrars, had been set up under the ownership of the clinical head of the orthopaedics department, because that was administratively expedient. The effect was an accumulation of 3,000 X-ray reports in the name of that consultant that had not been signed off by a medical officer and probably

never would be. Who owns the report? Is it the team? Is it the consultant? Is it the person who orders the test? There is a general rule in medicine that says if you ask a question you are responsible for dealing with the result. One of our problems is difficulty in identifying the ordering clinician. In our system each encounter with a patient is supposed to be owned by a consultant and so the responsibility for the results generated for that encounter is pinned on the consultant.

Despite the initial difficulties, the new system had to be implemented. The problem was to define criteria that would allow this to happen. Again, we made some mistakes. One of the major mistakes was to ask potential users how they thought it should work. Since they had no clear concept of the proposed system, some foolish replies were received and some of those were implemented. However, it was decided that when there was about 30% compliance with sign-off reporting requirements for the electronic system then its use should be mandated as the sole system. Increased training resources were applied to ensure that everybody who had to be able to use the system could use the system. A date on which paper reporting would be turned off was announced thus ending the dual system. This date had to be advanced because the Chief Medical Officer was becoming increasingly anxious that there were reports being issued on paper, there were reports being issued electronically into the results repository and he could not be sure whether a particular result had been actioned on paper, actioned in the results repository, or not actioned at all.

The printing of paper reports did not stop, however, they were just not issued. This practice continued for a week or so until the laboratory was sure that the new system did work and the outcry from the absence of the paper had died down. In retrospect, although there were no disasters, this was a wise precaution. A road show was set up and all the clinical units and departments were visited to market the advantages of the system and to try and find people within each department who were likely to be early adopters and who could lead the others along. The clinical champions were the Chief Medical Officer (because of his anxiety), the Clinical Director of Information Technology (the writer), and within each speciality, various enthusiasts who could be identified. A steering group was set up, which still meets once a month, to identify problems and their resolution.

The Business Rules

Business rules were created and can be described under 6 headings.

Report Security: There has to be a hospital policy on electronic identity. Essentially the hospital policy says you are responsible for everything that is done in your name on the computer system. If you give your password to somebody else, or if you foolishly choose a password that somebody else can guess, then that does not absolve you from responsibility. Passwords therefore required to be chosen carefully and guarded carefully. It is necessary to identify who does what within the results repository and so generic user codes were not allowed. For

example there is no user called 'Ward 7' in the system; it must be an identifiable person. User privileges were assigned by class of user because, of course, doctors want to look at results, so do nurses and so do medical students. User codes were set to expire on a given date and did expire on that date, unless renewed. Password expiry dates were not set. Many computer security experts will tell you that a password should expire after a fixed period, perhaps one week, or one month, or 3 months, to force the user to change his / her password. Experience with this approach indicates that when forced to change their passwords frequently, users write them down on 'post-it' notes and stick them on the terminal because they can never remember what the current password is. This seems much less secure than allowing users to keep the same password until they believe it has been compromised.

Report Access: The National Health Index number or the patient's encounter number is used to access the reports. Name-search enquiry is not allowed. This is to discourage people from looking up results on their neighbour, their workmate or their boyfriend, to find out what the latest HIV status report is. In order to look up a result, the enquirer must know the patient's number since that implies at least some level of involvement in that patient's care. We decided not to suppress results like HIV status and any result in the system is available to any user. There are no hidden or confidential results. Laboratories often change their minds between the issue of an interim report and the final report. The system is set up in such a way that it is possible to see the complete history of results for a particular test and see that it was initially reported by the laboratory as positive but later changed to negative. This transparency is very important to the clinician who has often been required to take action on the interim report.

The printing of records for temporary use is encouraged under certain circumstances, but, after use, they must be shredded and not be filed in the patient's case notes permanently. It is, therefore, vital not to write anything important on a paper report. The medical records department, when preparing outpatient records, would print out the latest laboratory results and put these in a separate sheet inside the cover of the case notes. This was because they were unsure that clinicians would be prepared to use the system in an outpatient setting. It turned out to be, in fact, quite nice for the patients because I discovered in my clinic that I had the results on paper there and knew that these would only be shredded, so instead I could give the patient a copy of the report to take away.

Report Acceptance: This is the equivalent of the 'initialling' the paper report. The rule is that all doctors can accept and all nurses, trainee interns, final-year medical students and ward clerks, all of whom had access to the system, can view reports but cannot accept responsibility for them. The House Surgeons decided that the two-click 'Yes, I want to accept this report' and 'Yes, I really mean that' slowed them down too much and so an alternative 'automatic' acceptance was implemented. In this case, any result brought up and not previously accepted by someone else, is accepted, unless the 'Unaccept' button is pressed. The doctor

can only unaccept a report signed by him/her. This has proved very popular. The consultant is the person responsible for report sign-off but the consultant is not the person who does it. It is generally delegated to his/her resident medical officers, the registrar and the house surgeon. Under certain circumstances report acceptance may be delegated to Diabetic Nurse Specialists and Dialysis technicians.

Report Redirection: When a patient changes from one carer to another, reports have to be redirected. The first attempt said if the patient is under the care of one consultant and changes to the care of another consultant, then all the relevant reports in the system should follow the patient to the second consultant. This was a disaster. The second attempt said that outpatient results are not transferred but inpatient results are. That was an attempt, for example, to avoid haematology outpatient results being sent to the orthopaedic consultant when the haematology patient became an orthopaedic inpatient. This too was unsuccessful because the system defines any patient who is at the hospital for more than 3 hours as having been admitted. This would include day patients for endoscopy or patients attending for chemotherapy. As a result in-patient results now do not transfer unless the patient is admitted through the emergency care department into an inpatient bed, in which case the reports from emergency care transfer to the inpatient consultant.

Report Referral: Report referral is to allow a report to be sent from one person for the attention of another and all doctors and trainee interns are allowed to do that in the system. However, they must give a reason for the referral in the form of an annotation.

Report Printing and Viewing: As previously stated there is unrestricted option to print from ECLAIR. However, in our hospital, none of these paper reports are permanently filed in the chart. All printed reports must be shredded. Any user can view any report but, for privacy, individual users are audited. The audit trail is open to every user (**figure 5c**). All those concerned about confidentiality of patient information view this as a very important feature, and it has enabled implementation of the system in a way that has not upset the confidentiality advocates.

Monitoring the System

Users are monitored to assess their number of outstanding unaccepted reports (**figure 6**) indicating the specialty, the care giver, the period of assessment and the number of unaccepted reports. A hit list of the top twenty is produced (**figure 7**) from which it can be seen, for example, that care giver A has 1441 outstanding unaccepted laboratory reports. Particular attention is paid to histology reports because of the potential for missing a diagnosis of malignancy, and the number of unaccepted reports has fallen from about 850, which is around about 2 weeks' worth of reporting, down to about 250.

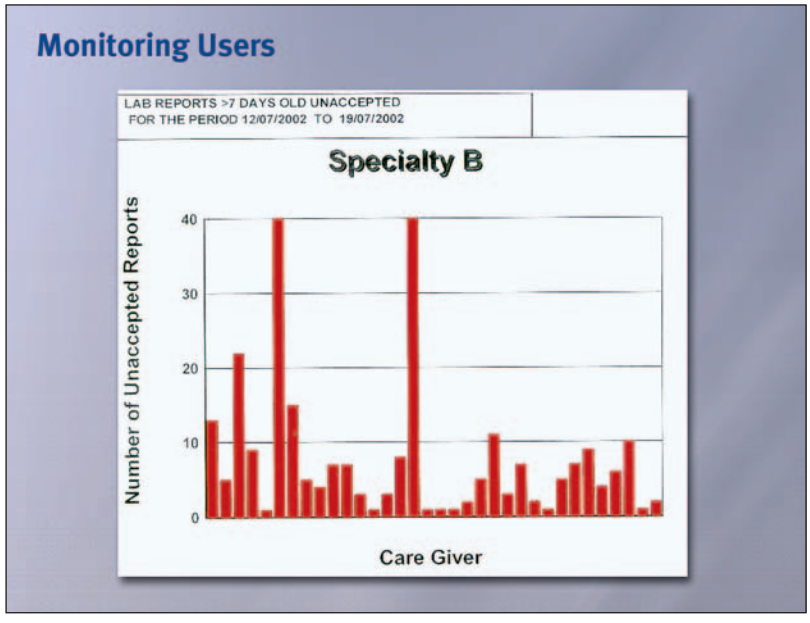

Figure 6
Non-acceptance of results: offenders within a particular specialty.

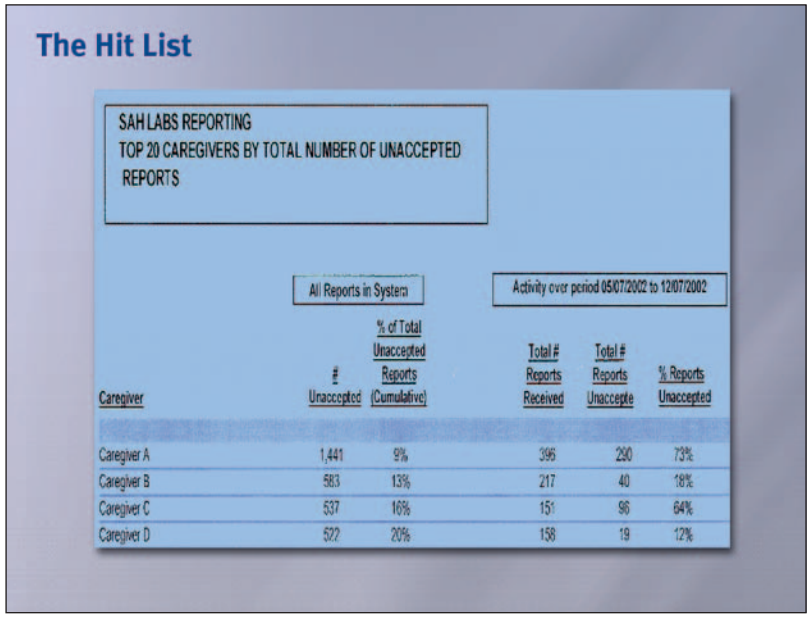

Figure 7
Top-twenty list of offenders.

Conclusions

In the four years the system has been operating a number of important advantages have been realised for electronic report delivery:

Immediate result delivery (As an example, the hospital has no blood gas analysers outside the laboratory and results are reported through the system within minutes)
Reduced laboratory telephone enquiries (The clinicians can find the results easily)
Improved access to historical results (They are all easily found at any time)
Improved access to results of tests processed by external laboratories (They are now collated in the same database and are available anywhere at any time).

Equally advantages have been realised for electronic report acceptance:

Permits removal of printed reports and improves utilisation of clinical records services
Is the first step towards total electronic medical records (EMR)
Provides accountability
Provides audit for clinicians
Identifies unaccepted reports.

Many measures of success can be identified for the system. It has been adopted by the Northern Hospital in Auckland, so it is now dealing with results for 2 major hospital groups accounting for about 800,000 patients. In the South Auckland group the system has been paperless for 2 years; it has dealt with 375,000 patients who have generated 3.7 million reports. Each week there are about 90,000 hits, and 50,000 of those relate to the current week, from 3000 users. The total number of reports received for the South Auckland hospital is 15,000 per week and 92% of those have at least been looked at by somebody.

The keys to success were:

- Top-level support
- Dedicated system administrator
- The ECLAIR helpdesk
- Clinical steering group
- Disciplined workflow processes
- Compressed software development cycle.

And what of the future? Well, within the existing system there is an orders module that allows the equivalent of ticking boxes on a paper request form electronically!

Two of the three local hospitals are already on board and the third one is about to join creating a regional repository for a total population of 1.2 million people. What will this achieve?

- Access to shared information
- Solving patient transfer issues
- 24 hour x 7 day access to reports across the region
- Complete results history which will reduce duplicate testing
- Improved patient experience
- Reduction in costs
- Reduced user training
- Standard data presentation across the region.

Finally the configuration for a multiple site regional electronic medical records system is illustrated schematically in **figure 8**.

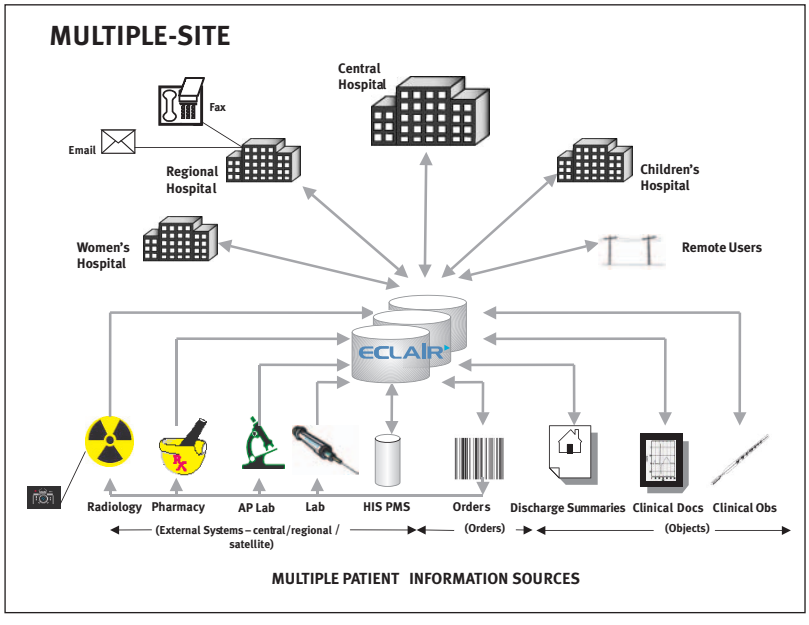

Figure 8
Multiple site regional electronic records system.

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