



Pacific Knowledge Systems

RippleDown and the Ideal Laboratory Information System

RippleDown used in conjunction with a conventional laboratory information system provides many of the features of the Ideal Laboratory Information System outlined by Sepulveda & Young (2012)

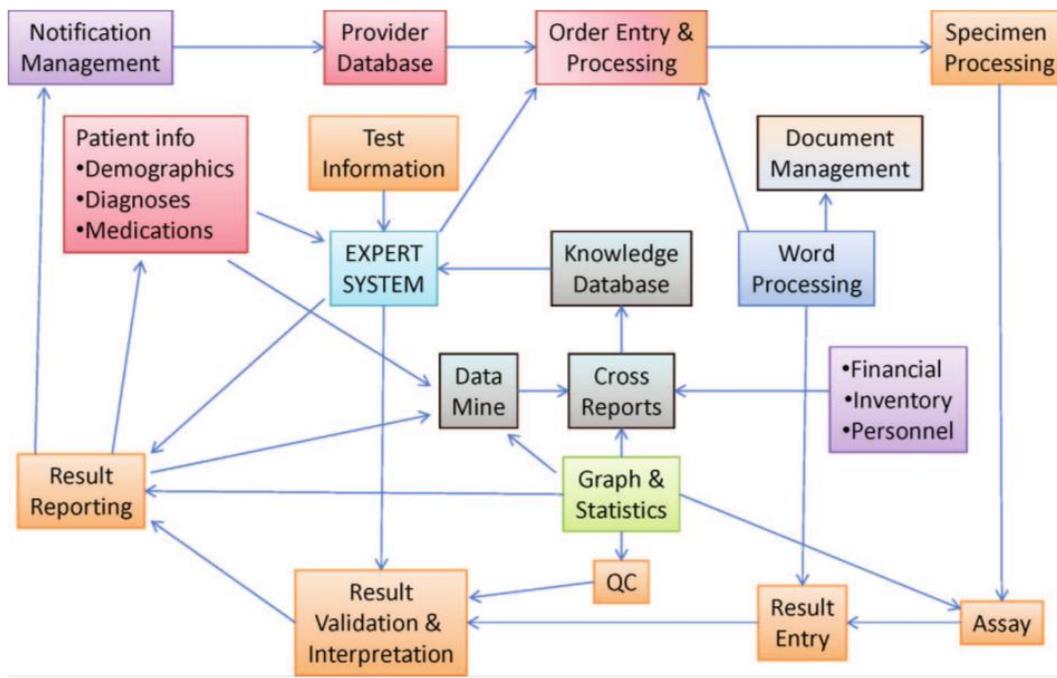
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Introduction

Sepulveda and Young have outlined the requirements for the Ideal Laboratory Information System (Sepulveda and Young 2012). The challenge they see for the laboratory information System (LIS) is not only to optimize handling of high-throughput and high-dimensionality tests within the laboratory, but to optimize how the laboratory tests contribute to personalized patient care.

They outline the features required for this ideal information system, shown below in Figure 1.



Modules contributing to the ideal laboratory information system.

Fig 1. The components of the ideal laboratory system taken from Sepulveda and Young (2012)

The ideal laboratory information system can largely be achieved now, by supplementing a current LIS with RippleDown. Figure 2 shows Sepulveda and Young's diagram again, but boxes shaded in blue for all the tasks where RippleDown contributes and the data that RippleDown can use and Sepulveda and Young believe should be used in the ideal Laboratory Information System. RippleDown knowledge builder module has been added to the figure, because the central feature of RippleDown is that the knowledge base is entirely under control of the pathologist or other senior laboratory staff, who can very easily change and add rules without reference to the IT department. Experience across hundreds of customer knowledge bases and thousands of rules, shows that a rule can be added and the knowledge base revalidated on average in about two minutes.

Order Entry and Specimen Processing

Conventional LIS all have modules for order entry, but at most provide some minimal check that the order is appropriate. The RippleDown Data Entry Auditor enables the Data Entry Manager to write rules to ensure that tests ordered comply with health rebate and insurance guidelines; that the tests are appropriate given previous tests and other information about the patient either current or from their history, that billing information is correct, that the referring and copy doctor details are correct etc. PKS customers using the RippleDown Data Entry Auditor make significant savings by ensuring inappropriate tests are not ordered, and contribute to patient care by helping to ensure optimal tests have been ordered and that reports are delivered to the correct doctors.

RippleDown users can also include rules for reflexive testing depending on results so far, slide-making decisions, and other workflow in the laboratory, improving both efficiency and patient care.

Result Validation and Interpretation

Interpretation

A major role for RippleDown is in providing interpretative comments for laboratory results. Rather than a simple piece of canned text, the pathologist can write rules that take into account all the information that is available in the LIS: previous results and whatever clinical notes or other information is available. This allows very patient specific and useful advice to be provided. Providing high quality advice does impact on medical care. For example a laboratory using RippleDown to provide information about lipid results showed a consequent decline in patient's low-density lipoprotein levels (Bell, Bender et al. 2013).

The particular advantage of RippleDown is that rules can be written very rapidly and easily taking on average only 2 minutes for a pathologist to write a rule and revalidate the knowledge base (Compton, Peters et al. 2011). This means highly specific rules can be written to produce the reports the pathologist believes are most useful for the clinicians and patients that use that particular laboratory service.

Validation

RippleDown includes a Validator module where the pathologist or other senior staff will accept or reject the comment produced by RippleDown for a report. If the comment is rejected, the case can then be referred to the Knowledge Builder to add another rule if appropriate. Statistics are also provided in the Validator on how often a particular comment is changed, so when the pathologist has sufficient confidence in a comment being made reliably, they can choose to have reports with this type of comment auto-validated – sent directly to the referring clinician without manual checking. Some reports might rapidly be set to 100% auto-validation, while reports for some other patterns of results might never be auto-validated. Pathologists can also

choose to auto-validate some fraction of the results for a particular pattern, so they can still carry out some checking on reports that are being auto-validated. Across 7.5 million reports from 185 knowledge bases in 12 laboratories using RippleDown the auto-validation level was 85%. (Auto-validation with RippleDown (2013)).

RippleDown auto-validation also provides auto-verification of laboratory results in the conventional sense of limit checks, delta checks and biological validation, i.e. checking whether a result for a patient is plausible given the results for other tests, past results, clinical information about the patient and so on. In writing a rule to provide a very precise comment, the pathologist is also identifying a particular pattern of results as being plausible with respect to that comment. That is, in providing clinical advice for a set of results the pathologist is implicitly carrying out limit checks, delta checks and biological validation. Pathologists can also write rules which identify cases which specifically require manual validation. The auto-validation achieved with RippleDown across a wide range of different domain areas of 85% is extremely high. It is also a by-product of generating interpretative reports, rather than using two different technologies for interpretative reports and validation.

Result Reporting

RippleDown can be used not only to provide interpretative comments for the referring clinician, but can be used to control the formatting of the report, so very high quality pdf reports can be produced where results are organized, tabulated and highlighted making very clear the key issues that require consideration. Results can also be accompanied by graphs indicating trends over time, or the position of a result with respect to its normal range. Report formats can be highly customised, i.e. not just for the clinical domain but according to the referring doctor's preferences. Reports can also be sent out multiple languages, with some laboratories send out reports in one of three different languages depending on the recipient.

RippleDown can also be used to produce a personalised letter about a patient. For example for bone mineral density a report might refer to the patients clinical history, previous results, fractures, height and weight changes, medications, calcium intake and so on. Another type of comprehensive report is a cardiac risk assessment after hospitalisation for a myocardial infarct to help guide post-hospitalisation rehabilitation and health care. This has been used successfully to reduce the likelihood of an early repeat hospitalisation, which is not funded under US Medicare rules (Zabaleta, Burgess et al. 2012). In providing highly specific advice RippleDown can also be used to integrate information via grid or cloud access from multiple sources (Balis 2012), going beyond the requirements for the "ideal" laboratory information system.

Notification Management

RippleDown can also be used to manage the way laboratory results are provided to clinicians. For example RippleDown has been used to generate real-time alerts for possible cardiac events where no adverse events were missed and false positive alerts were drastically reduced (Crowgey, Phalor et al. 2010).

Rules can be written to instigate reflex testing based on current results. Experts can also write rules to flag that certain patterns of results, perhaps limited to certain referring clinicians, should result in a phone call.

Data Mining, Cross-Sectional Reports, Graphs and Statistics

Since RippleDown classifies patient results into whatever fine (or coarse)-grained patterns a pathologist wishes to use, it can be very easily used for data mining. It is far easier to write a rule to retrieve a complex pattern of results than to write a data base query. For example one could write rules to retrieve all patients who had an abnormal pattern of results, and distinguish those who were on relevant medication or not according to the clinical notes available. Such discrimination could be used for example to identify referring clinicians with seemingly different treatment patterns for the same type of patients. RippleDown can output such data in spreadsheet format for further manipulation and display, or automatically forward such results to a public health registry.

RippleDown also provides various dashboards to monitor laboratory performance. For example the auditor dashboard provides feedback, including graphs, on errors in data entry, and can be used to assist individual staff with personalized training programs.

Result Entry

Although not normally required in Chemical Pathology, where results entry is either on-line or is a simple manual procedure, there is also a RippleDown Smart Forms module. The Smart Forms provides a result entry environment for more complex manual result entry. It dynamically guides the process of entering data depending on the data already entered or previously available. Smart Forms is again controlled by rules to suit the particular requirements of that laboratory for data entry. As with all RippleDown applications, end users can very rapidly and simply enter the rules.

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