



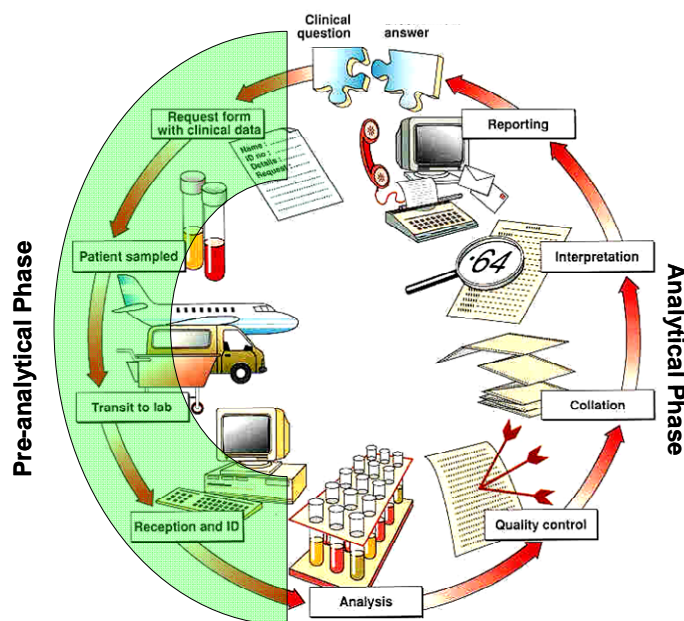
# ATOMS

## A Laboratory Specimen Collection and Management System

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## INTRODUCTION\*

For patients, specimen collection errors during the pre-analytical phase can lead to medication errors, inappropriate or delayed therapy, missed therapy, possibly prolonged hospital stays, increased disability or worse. For the hospital concerned, ***specimen collection errors can have a major negative impact on finances, as measured in time spent tracking and correcting errors, performing re-draws or repeat testing, as well as the costs associated with unnecessary treatment.*** The laboratory plays a critical role in creating and reducing clinically significant errors.



“We know that, although the laboratory represents a small percentage of medical center costs, it leverages 60-70% of all critical decisions, e.g. admission, discharge, and drug therapy.”

*Forsman, RW. Why is the laboratory an afterthought for managed care? Clinical Chemistry 42(5):813-816, 1996.*

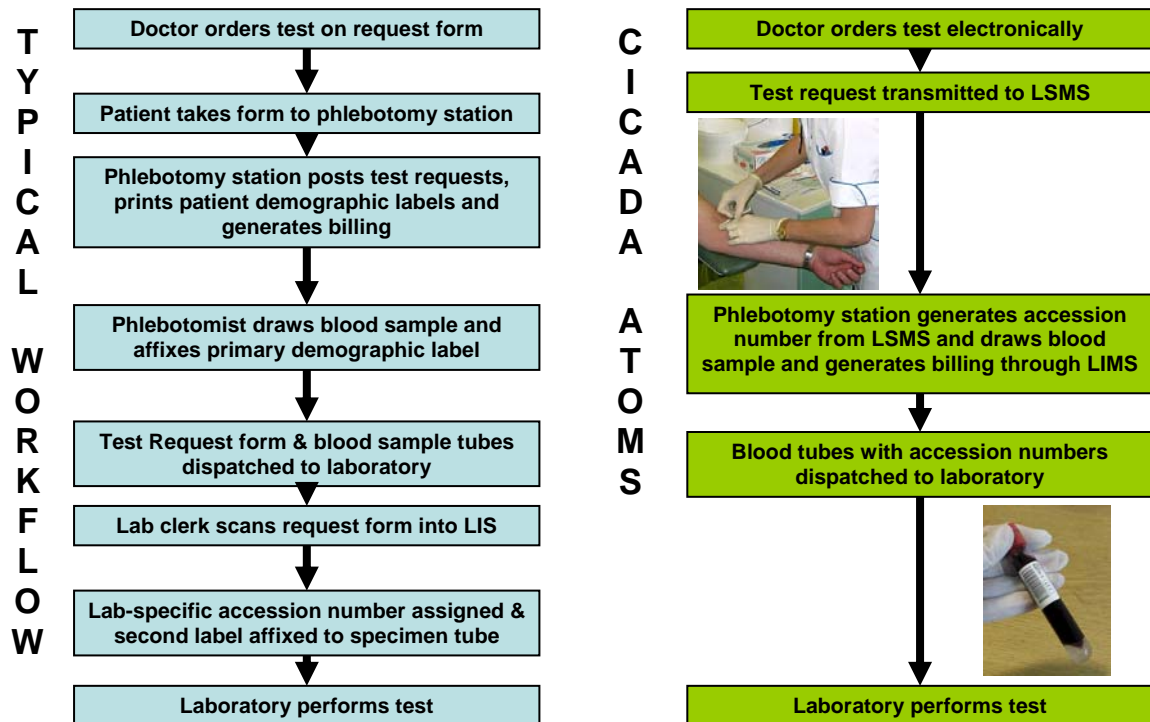
## CICADA'S ATOMS

Cicada's ATOMS\* is an essential laboratory workflow component that integrates seamlessly with the resident Laboratory Information Management System (LIMS) of the hospital to facilitate specimen collection by nurses, phlebotomists and doctors. ATOMS comes with its own user-centric designed Clinician Order Entry system or it can be integrated into the existing Order Entry system. ATOMS is a focused ***laboratory order and specimen collection software system*** which supports applications used by doctors, nurses and phlebotomists, specifically for the ordering and management of laboratory samples. ATOMS facilitates the complete automation of the laboratory ordering process, from the point of physician-patient contact until sample delivery to the laboratory, through the integration of a novel software solution and physical output devices consisting of wireless hand-held devices and remote mobile printers. Successful implementation of ATOMS will result in a unique

\* Singapore Patent Application No: 200705750-8

blend of technology which will ensure that laboratories receive complete electronic laboratory orders and pre-labeled sample tubes which are ready for direct analyzer placement. ATOMS also integrates seamlessly with the healthcare facility's electronic medical records and laboratory information systems. One of the greatest benefits of the solutions is the efficient flow of real-time information that is critical to implementing effective and safe treatment plans.

Cicada's ATOMS will enable the attending clinician (doctor or phlebotomist) to perform an electronic test order which will interface and integrate with the resident LIMS. Cicada's ATOMS will collect and sort these test requests and present them to the nurses/phlebotomists as meaningful information to carry out their duties effectively and productively. As the patient appears at the specimen collection (blood, urine, stool, mouth swab) station, ATOMS will facilitate the right tests for the right patient by ensuring that there is synchronicity between patient ID and tests ordered. ATOMS is configured as a "closed loop" system, customized and designed to specifically maximize the efficiency of the specimen collection process, while eliminating any opportunity for error. The illustration below describes the workflow of ATOMS as compared to most current typical workflows.



## THE UNMET NEED FOR LABORATORY SPECIMEN COLLECTION AND MANAGEMENT

### *Information Technology Adoption in Hospitals*

Since the advent of the computer revolution, clinical laboratories have been early adopters of Information Technology. Computers, hardware and software have been integral to conducting and managing the testing process, as well as reporting and storing results. As stand-alone powerhouses of laboratory informatics, these legacy laboratory information management systems (LIMS) were originally deployed to be silos of information, with little need to interact with other systems. Today's laboratory operation requires much more.

Laboratories looking for operational success are fueling the next wave of IT investment, moving away from the monolithic LIMS to enterprise-wide solutions. Laboratories are driving the market to produce sophisticated solutions that meet their individual needs and address the complexities of their individual markets. Connectivity and communication are critical components for laboratory success. As the laboratory reaches out, interacting with constituents beyond its original service area, its ability to provide superior customer service and remote access to laboratory information becomes a salient business driver, requiring IT to push the LIMS beyond initial design.

### *Errors in Test Orderings*

In 1999 the US Institute of Medicine (IOM) reported in "To Err is Human: Building a Safer Health System" that the medical community was responsible for many serious errors in the



delivery of care. In 2002 a report by the Rand Corporation on the delivery of care in over 20 centers in urban US, estimated that nearly half the patients treated for a variety of diseases had not met the approved standards of care. Of particular importance in this report was the frequent citation of the laboratory testing procedure

as an important contributor in improper care delivery. **The US 2004 National Patient Safety Goals lists, as an important priority, the need to improve the accuracy of patient identification.**

Laboratory-related ward ordering and sample collection errors are significant and costly. Between 32-75% of laboratory errors originate in the pre-analytical phase and most of these are identification errors, at steps which are beyond the control of the laboratory. These errors and adverse events occur where clinician order entry has impact. Adoption of the proposed electronic test ordering management system reduces error and permits IT opportunities in medical administration and audit.

Doctors in hospitals make multiple requests for blood tests each day and ***mistakes made in test ordering can be serious and expensive***. The current process of test ordering begins with a request for blood samples by doctors. Patients' information and test requests are recorded in paper forms and passed on to phlebotomists to collect blood samples from patients. Different colored tubes have to be used for different tests, and at the moment knowledge of which color tube to use resides in the phlebotomists' memory. Tubes of blood samples are laboriously labeled with the patient's name and identification number which is readily available in the ward for transit to the laboratories, where they are registered into the LIS (a process known as accessioning) and a new sticky label with this accession number is stuck onto the tube before being put into the laboratory test cycles where tests are conducted on the samples. Test results are subsequently transcribed into a typical LIS for further analysis and quality control.

While the information management process of test ordering may not seem complicated, there are many areas where errors can happen. For example,

- The manual recording of patient's information in the order form.
  - ♦ *Likely error: Patient's name may be spelt wrongly resulting in wrong patient identification.*
- The manual recording of medical professional's information in the order form.
  - ♦ *Likely error: Medical professional's name may be spelt wrongly resulting in wrong medical professional identification.*
- The manual recording of test orders.
  - ♦ *Likely error: Recorded tests may not be understood properly by phlebotomist due to illegible hand-writing.*
- The manual labeling of tubes containing blood samples.
  - ♦ *Likely error: Wrong labels may be used.*
- At the laboratory, a laboratory receptionist enters information about the samples into the Laboratory Information Management System.
  - ♦ *Likely error: Patient's information may be entered wrongly.*
- At the laboratory, a second label with a new laboratory accession number is generated. This second label has to be checked against the record to ensure that they tally.
  - ♦ *Likely error: Wrong label is used.*

## Costs of Errors

Studies carried out in the United States (e.g. Bologna, Hardy, Mutter, 2001) estimated the **cost to hospitals due to specimen-related errors at over US\$200 million per year**. The cost is not only limited to the hospitals, patients are also paying for it. Patients suffer from inappropriate, delayed or missed therapy resulting in prolonged hospital stay, debility and diagnosis. In some cases, the errors have led to deaths in hospitals.

## The Need to Improve the Accuracy of Patient to Tests Ordered

While we can blame such mistakes on human errors, it does not solve the problem. The real problem lies in the **inadequacy of the current system in managing the collection and handling of the samples for testing**. Current systems do not provide sufficient safeguards against errors! With increasing complexity of the laboratory testing protocols, it has become apparent that new and creative mechanisms in 'pathology informatics' are necessary for clinical error reduction.

The 2005 US National Patient Safety Goals released by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has highlighted the need to improve the accuracy of patient identification whenever retrieving bloods samples and other specimens for clinical testing.

## ATOMS VALUE PROPOSITION

- **Modular design**
- **Operating system independent**
- **Seamless integration with current infrastructure**
- **Interoperability based on international standards (HL 7, ICD-9, SNOMED-CT)**
- **User-centric**

Welcome, Anto Mette Date: 17/04/2007  
Time: 04:49:19 PM

[Logout](#)

Specimen Collection for Patient: **Chief Cicada**

**Patient Particulars**

Name

NRIC


DOB

Age

Sex


Location

Draw Tube 1/4 +



NA, K, URE

Draw Tube 2/4 +



NA, K, URE

Draw Tube 3/4 +



FBC

Draw Tube 4/4 +



Plain 20ml  
TPU

RePrint All LabelsEnd Collection

**Test Request Summary Table**

AccessNo.: 6555444134  
Comments: NA

Order ID	Test Code	Ordered By
170	NA	Antony Eng
170	K	Antony Eng
170	URE	Antony Eng
171	FBC	Antony Eng
172	TY	Antony Eng

Visual representation of specimens to be collected by phlebotomists/nurses/clinicians

ATOMS Laboratory Tests Ordering  
 User ID: s33330000 Date: 06/02/2007  
System Time: 03:09:32 P.M.

**Step 1:** Scan/Enter Patient NRIC:

Main | View Past Orders | Manage Favourites | Patient Management

**New Order For Patient: Chief Cicada**

**Patient Particulars**

Name	
NRIC	
Date Of Birth	
Age	
Sex	
Case Number	1560506901H
Location	NCMMED
Urgent	<input type="checkbox"/>
Order Comment	
Doctor	

**Step 2:** Select lab tests. Enter Doctor's name, if applicable.

**Step 3:** Add to Cart. Remove from cart if selected test (s) is not required. Enter comments, if any.

**Step 4:** Preview and print test request.

**Step 5:** Save test request.

**VIEW TEST(S) BY FAVOURITES**

**VIEW TEST(S) BY LAB FORMS**

Clinical Chem Form

Search (by test code) :

Search (by test name):

**VIEW TEST(S) BY ALPHABETICAL ORDER**

**VIEW TEST(S) BY CATEGORIES**

Allergy

**Search Results:**

**FORM: Clinical Chem Form**

<input type="checkbox"/> ACMP Acetaminophen	<input type="checkbox"/> EF9 f9 Rice
<input type="checkbox"/> ALBU Albumin, urine	<input type="checkbox"/> FAB12 Folate/Vitamin B12
<input type="checkbox"/> ACR Albumin:Creatinine, urine	<input type="checkbox"/> FP5 fp5 Food Panel 5
<input type="checkbox"/> ALGP Allergy Panel	<input type="checkbox"/> EG2 g2 Bermuda grass
<input type="checkbox"/> AAT Alpha -1-Antitrypsin	<input type="checkbox"/> GENP Gentamicin, Peak
<input type="checkbox"/> AMIP Amikacin, Peak	<input type="checkbox"/> GENT Gentamicin, Trough
<input type="checkbox"/> AMIT Amikacin, Trough	<input type="checkbox"/> HPT Haptoglobin
<input type="checkbox"/> AMYU Amylase, urine (random)	<input type="checkbox"/> HCY Homocysteine, plasma
<input type="checkbox"/> APOS Apolipoprotein A1 & B	<input type="checkbox"/> HSCRPhs-CRP
<input type="checkbox"/> B2M B-2-Microglobulin	<input type="checkbox"/> EI6 i6 Cockroach
<input type="checkbox"/> BJP Bence Jones Protein	<input type="checkbox"/> IGE Immunoglobulin E
<input type="checkbox"/> BHC7B-hCG, serum quantitative	<input type="checkbox"/> IGA Immunoglobulin A
<input type="checkbox"/> EC1 c1 Penicilloyl G	<input type="checkbox"/> IGD Immunoglobulin D
<input type="checkbox"/> EC2 c2 Penicilloyl V	<input type="checkbox"/> IGG Immunoglobulin G
<input type="checkbox"/> ECS c5 Ampicilloyl	<input type="checkbox"/> IGM Immunoglobulin M
<input type="checkbox"/> EC6 c6 Ampicilloyl	<input type="checkbox"/> EK82 k82 Latex
<input type="checkbox"/> CA125 CA125	<input type="checkbox"/> LDPEP LD Isoenzymes
<input type="checkbox"/> CA153 CA15-3	<input type="checkbox"/> LI Lithium
<input type="checkbox"/> CA199 CA19-9	<input type="checkbox"/> LPA Lp(a)
<input type="checkbox"/> CAER Caeruloplasmin	<input type="checkbox"/> EM1 m1 Penicillium notatum (random)
<input type="checkbox"/> CAU Calcium, urine (random)	<input type="checkbox"/> MGU Magnesium, urine (random)
<input type="checkbox"/> CBZ Carbamazepine	<input type="checkbox"/> MTX Methotrexate
	<input type="checkbox"/> MP1 mp1 Mold Panel 1

**Test Requests Table**

Test Code	Doctor Comments
ACMP	<input type="text"/>
AMIP	<input type="text"/>
AMIT	<input type="text"/>
AMYU	<input type="text"/>

### Clinician's Test Order Entry Module

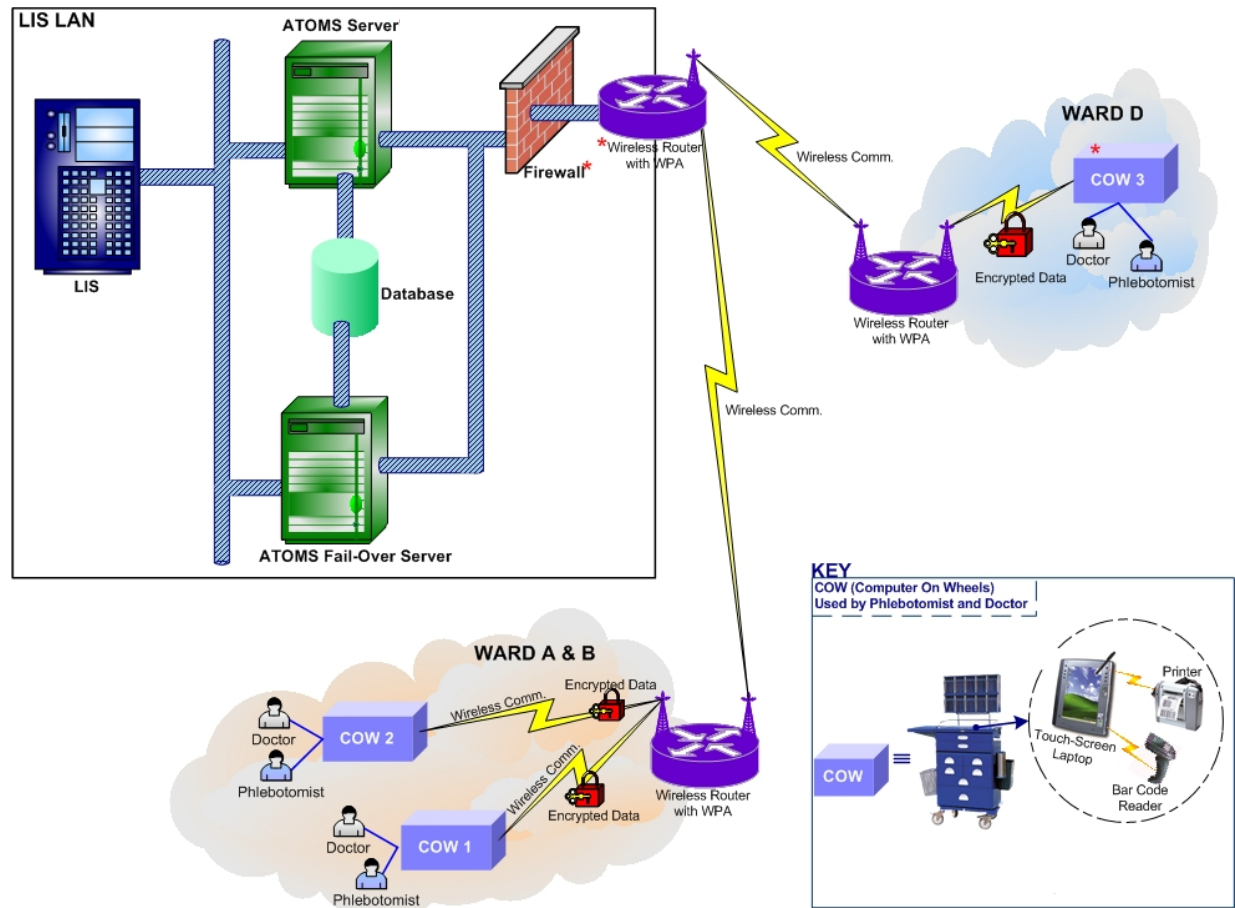
#### **The Benefits of Cicada ATOMS**

1. Bedside pathology ordering by doctors and nurse practitioners for hospital patients.
2. Robust positive-patient identification
3. Bedside phlebotomy management and order entry
4. Electronic linkages between LSMS and the LIS (Laboratory Information System) using HL7 bi-directional communication standards.
5. The savings in time and associated costs arising from the use of LSMS can be categorized into the following areas:
  - Labor savings in collection and receipt process equivalent to at least 2 FTEs (full-time equivalents).
  - Label and material savings due to label errors resulting in multiple sticks.
  - Labor time associated with handling lost or misplaced samples.
  - Labor time associated with identifying or correcting errors.
  - Management of time in corrective action, interviews, and reports.

US statistics quote figures of 770,000 annual deaths and injuries, up to 6 per 100 unanticipated bed occupancies, and US\$5.6 million in cost. **Studies in the United States have shown that on average, a hospital can save up to US\$200,000 per year** (Bologna, Hardy, Mutter, 2001).

Major regional hospitals are equivalent in size to American hospitals, and assuming equivalent standards of practice, **each hospital can be expected to benefit from savings of \$320,000 per year providing a significant return on investment.**

The schematic below illustrates the use of LSMS in hospital environments.



*Clinicians can carry out test orders through computer terminals from anywhere in the hospital. The test orders are stored in the ATOMS server. During sample collection, the phlebotomist or nurse accesses the ATOMS application through computer-on-wheels that may be in a wired or wireless environment. The ATOMS server will access the hospital's LIMS or LIS LAN server to get the required accession numbers for the patient samples.*