

# Territory-wide Sharing of Digital Images in the Hong Kong Hospital Authority

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Hong Kong Hospital Authority

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## Outline

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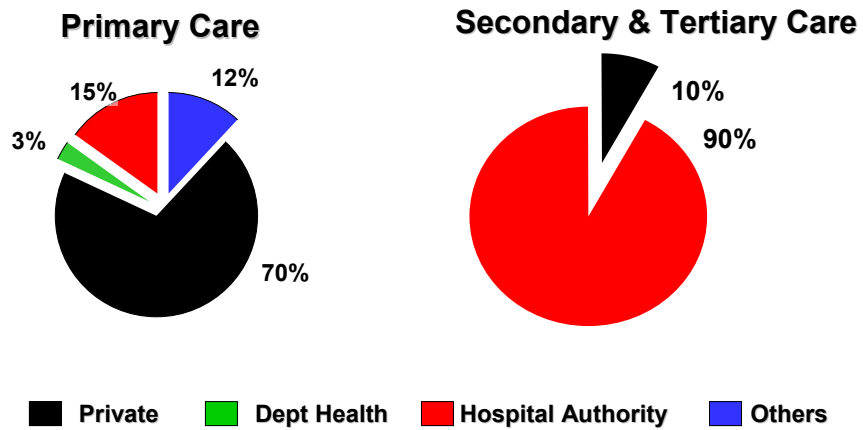
- Development of Electronic Health Records in Hong Kong
- The Image Distribution Project 2004
- Success Factors
- Conclusions

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## Healthcare in Hong Kong



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# HK Hospital Authority (HA)

- o Established 1991
  - 43 Public Hospitals
  - 46 Specialty Clinics
  - 74 General Clinics
  - **13m Outpatient attendances**
- o 29,022 Beds
  - **2.4m AED attendances**
  - **1.2m Inpatient Discharges**
- o 52,000 Staff
  - 4,454 Doctors
  - 19,674 Nurses
  - 4953 Allied Health Staff
- o 6.9 million population
- o HA budget:
  - US\$4 billion 5% GDP
  - IT budget: 1.5%



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# The Clinical Management System (CMS)

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病房  
WARD

門診  
CLINIC

常用連結  
USEFUL LINK

[PWH Intranet Home Page](#)  
[HA Intranet](#)  
[HA News Update](#)

Hospital Authority  
Clinical Management System

Version 2.0.0059.004

Lagon:

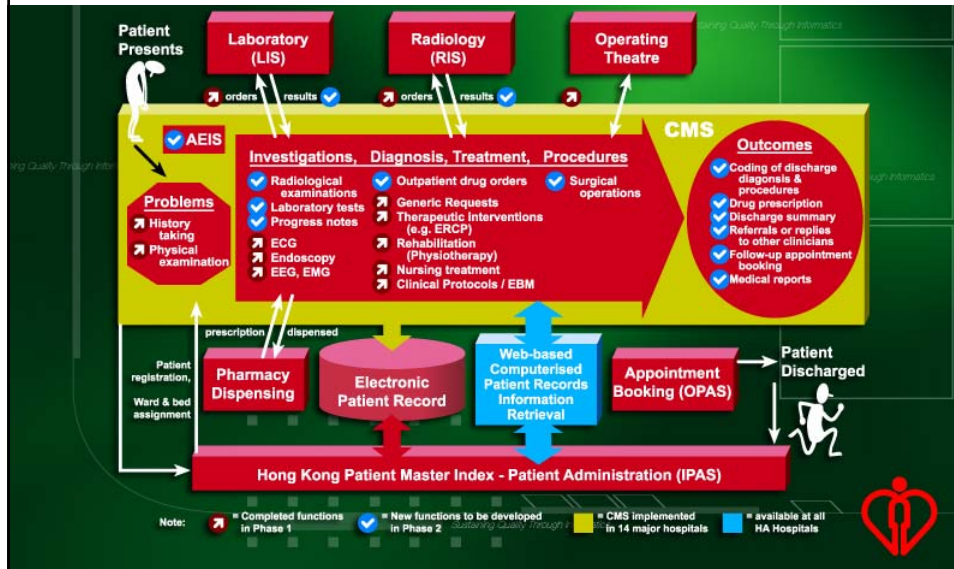
Password:

Important Notes

1. All patient information is strictly confidential
2. Staff may only use the CMS for authorised purposes
3. All access to CMS is logged
4. Please logoff immediately after use
5. Please ensure you have verified the content before you sign the computer printouts

PWH

## A Single Platform



## The Clinical Management System (CMS)

- Used at all hospitals and clinics in the HA
  - 30,000 users
  - 12,000 workstations
- Multidisciplinary
- Information sharing
- Built by the HA ITD since 1993



## A long journey of development

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- 1990 “Green field” – no legacy system
- 1991 Patient Administration only
- 1992 Pharmacy System added
- 1993 Lab results online
- 1994 Radiology Information System
- 1995 Clinical Management System
  - Order Entry & Outpatient progress notes & Discharge summaries
- 2000 Electronic Patient Records
- 2004 Radiology Images online
- 2006 ePR Sharing with Private Sector



## Each Day

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- 12,000 users
- 90,000 patients
- 2,000,000 transactions with data entries
- 300,000 data retrievals



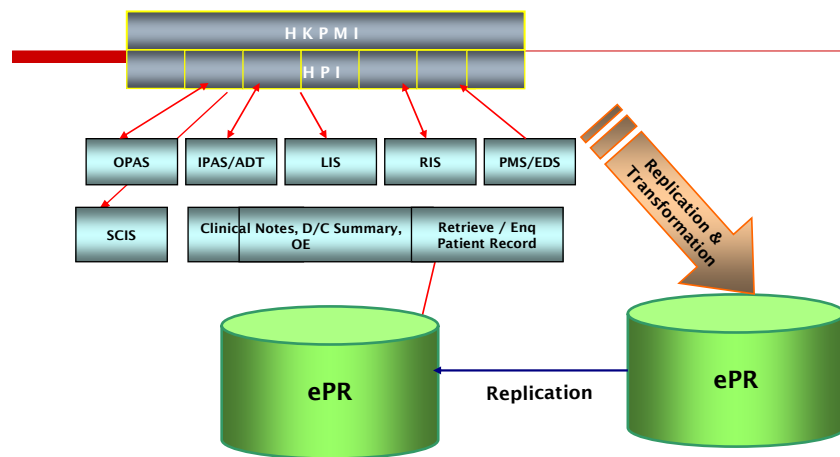
## Functionality

- Direct clinician entry
  - Orders
  - Diagnoses, procedures, discharge summaries
  - Reports and letters
  - Notes
- Departmental data
  - Laboratory data
  - Radiology records
- Review, audit and research

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## Architecture of ePR



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Common Front End



## The ePR (Electronic Patient Record)

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- The comprehensive lifelong (womb to tomb) multimedia record of all relevant clinical data
- Patient centred vs function based
  - Breaking the silos
- Corporate based from hospital based
- Standardization of structure and content



## Huge Data Warehouse

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- 7.6 million patient records
- 57 million episodes of care
- 540 million lab results
- 34 million radiology results
- 400,000 image studies
- 1.5 Terabytes data volume + 3 Terabytes images data
- Sub-second response time
- Near real time update



HA - Tree View Prototype (build 041008) - Microsoft Internet Explorer

Address: http://epr.home/epr/Content/login\_validator.asp

HKID: **CHENG, MEI CHI SALINA** Name: **CHENG, MEI CHI SALINA** DOB: 02/03/1956 (Exact? Y) Age: 48y Sex: F

**Diagnosis**

Last Entry	Description
03/12/2004 (x14)	End Stage Renal Failure
31/12/2003 (x4)	Chronic renal failure
13/08/2003	Vomiting alone
21/07/2003	Peritonitis related to continuous ambulatory peritoneal dialysis
23/06/2003	Kidney dialysis as the cause of abnormal reaction of patient, or of later complication
14/03/2002	Hypotension
31/10/2001	Other specified surgical operations and procedures causing abnormal patient reaction, or later complication
31/10/2001	Wound bleeding, postoperative

**Procedure**

Last Entry	Description
03/12/2004 (x12)	Haemodialysis
16/12/2003 (x2)	Tenckhoff catheter removal
14/11/2003	Creation of arteriovenous fistula
16/09/2003 (x2)	Insertion of Tenckhoff catheter
13/07/2003	Bone marrow examination
13/07/2003	Echocardiography
13/07/2003	Ultrasonogram of abdomen
13/07/2003	Whole body scan, gallium
13/07/2003	CT abdomen with contrast
13/07/2003	Removal of haemodialysis catheter
13/07/2003	Insertion of haemodialysis catheter

**Drug Allergy**

Description: Nil

**Current Medication**

Last Dispensed	Drug name (Route)
11/10/2004	AMITRIPTYLINE HCL (Oral)
11/10/2004 (x2)	ERYTHROPOIETIN BETA (Injection)
11/10/2004 (x2)	SUSTANON 250 (Injection)
11/10/2004	SODIUM BICARBONATE (Oral)
11/10/2004	FAMOTIDINE (Oral)
11/10/2004	ALUMINIUM HYDROXIDE (Oral)

**Recent Schedule**

Date	Hospital / Clinic	Service Type	Description
24/01/2005 08:45	YMT/YMTSCE	SOPD	Medicine / Ne
06/12/2004 13:30	QEH	IP	Medicine / Int

## Longitudinal laboratory

Most recent from the left Page 1 of 5

Reference Date	15/12/2002	15/12/2002	14/12/2002	13/11/2002	12/11/2002	19/10/2002	18/10/2002
Reference Time	Not Stated	Not Stated	Not Stated	Not Stated	Not Stated	Not Stated	Not Stated
Hospital Code	TMH	NDH	PWH	AHN	PYN	TMH	KWH
Haemoglobin, Blood	--	9.1 ↓	--	11.4 ↓	12.8	--	12.6 ↓
RBC	--	3.82	--	4.15	4.34	--	3.94 ↓
HCT	--	0.275 ↓	--	0.343	0.375	--	0.357 ↓
MCV	--	72.0 ↓	--	82.7	86.5	--	90.6
MCH	--	23.9 ↓	--	27.4	29.5	--	32.0
MCHC	--	33.1	--	33.1	34.1	--	35.3
Platelet	--	516 ↑	--	368 ↑	514 ↑	--	192
WBC	--	7.5	--	10.7 ↑	7.1	--	5.0
APTT	29.5	--	--	--	--	--	--
Prothrombin Time	11.9	--	--	--	--	--	--
Sodium	--	--	137	--	--	--	--
Potassium	--	--	4.0	--	--	--	--
Urea	--	--	5.2	--	--	--	--
Creatinine	--	--	94	--	--	--	--
Protein, Total	--	--	71	--	--	--	--
Albumin	--	--	41	--	--	--	--
Bilirubin, Total	--	--	2	--	--	--	--
Alkaline Phosphatase, Total	--	--	90	--	--	--	--



## Data

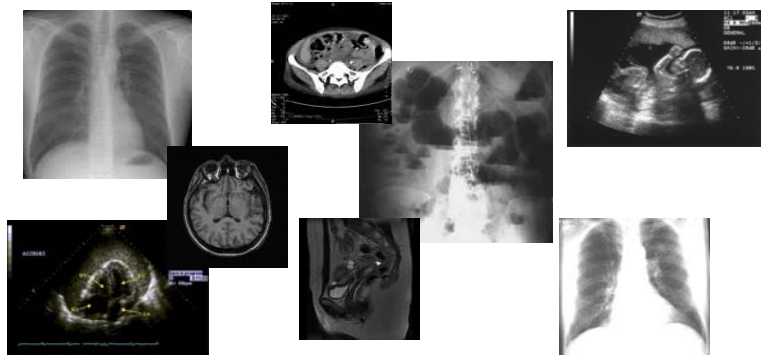
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- Simple numeric/text
- Codes
- Structured data
- Images/PDFs



## The ePR-Image Integration Project

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## Images in the Hospital Authority

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- Picture Archive and Communication Systems
  - Departmentally implemented and operated
- Increasing demand for image integration into CMS/ePR
- Estimated cost of comprehensive corporate PACS
  - HK\$220million
- Budget for current project
  - HK\$20million



## Project Brief

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- Distribute radiology images to clinicians via electronic Patient Record (ePR) on existing CMS workstations
  - Consolidate images from existing mini-PACS
  - Compress to clinical reference quality
  - **Integrate images into the ePR/CMS**
  - Gateway to support teleradiology
  - An infrastructure for all image types



## **An interim step to full PACS**

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- “Reference quality” images vs “full quality”
  - 10 – 30 x compression
- Image selection vs store all images
  - Massive reduction for multidetector scanners
- Not “filmless” (maybe “less film”)
  - No requirement for 99.999% availability
- Leverage of existing infrastructure
  - No new networks and workstations



## **Major issues**

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- Workflow
- Image quality
  - Clinical suitability



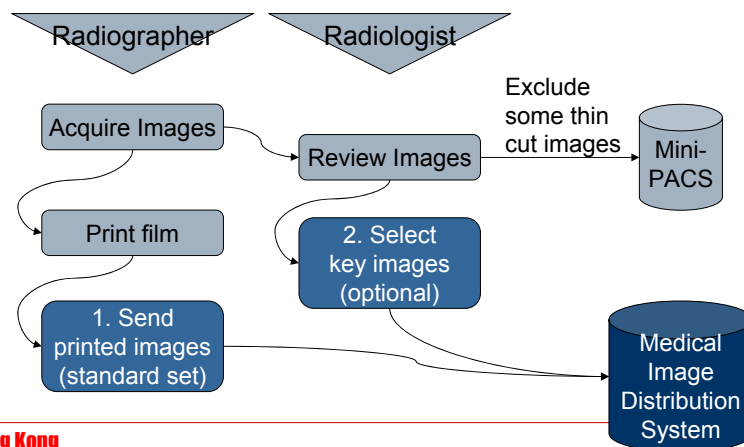
## Workflow - Do more or less?

		Do More?	Do Less?
Image selection	Radiology	Select images	-
Image Archive	Radiology	Admin/support image transfer	
Image Distribution	Radiology	Support calls Training	(Re-)print film File film & envelope Track of missing film
	Clinical		Wait for old film Loan film Re-take examination

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## Images Selection

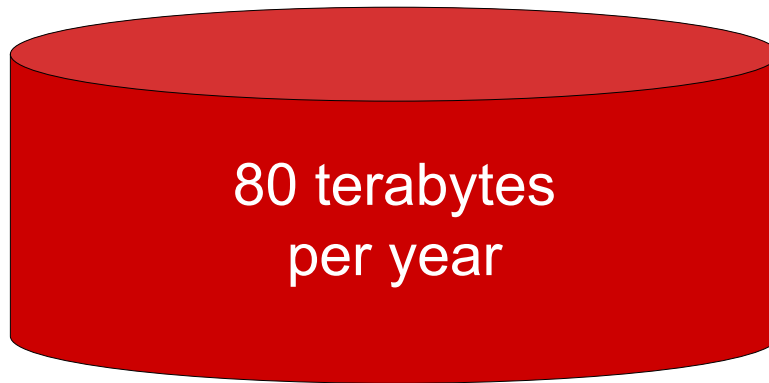


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## Data volume

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## Research on image quality

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JPEG compression 15x “visually lossless”

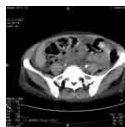
*Kocsis O et al Comp Meth Prog Biomed. 71(2):105-15*

MRI 10-20x no impact on brain lesion detection



*Tera S et al, J Digit Imaging, 13(4):178-90*

CT scans 8-20x acceptable



*Zalis ME, et al, Radiology 220(2):387-92*

*Megibow AJ et al. Imaging, 15(2):84-90*

*Zheng LM et al, Acta Radiol;41(2):116-21*

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## More studies

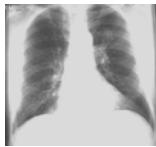
---

Ultrasound 9x no impact



*Persons KR et al  
J Digit Imaging 15(1):15-21*

Chest radiographs 15-40x acceptable



*Slone RM et al, Radiology 215(2):543-5  
Savcenko V et al, Radiology, Vol 206, 609-616  
Kotter E et al, Investigative Radiology, 38(5):243-9  
Erickson BJ et al, J Digit Imaging, 10(3):97-102*



## Image quality

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- What compression ratio is acceptable?
- Type of study
- Degree of pathology
- Context-specific
  - Initial impression
  - Definitive diagnosis
  - Review and study comparison



## Image quality study

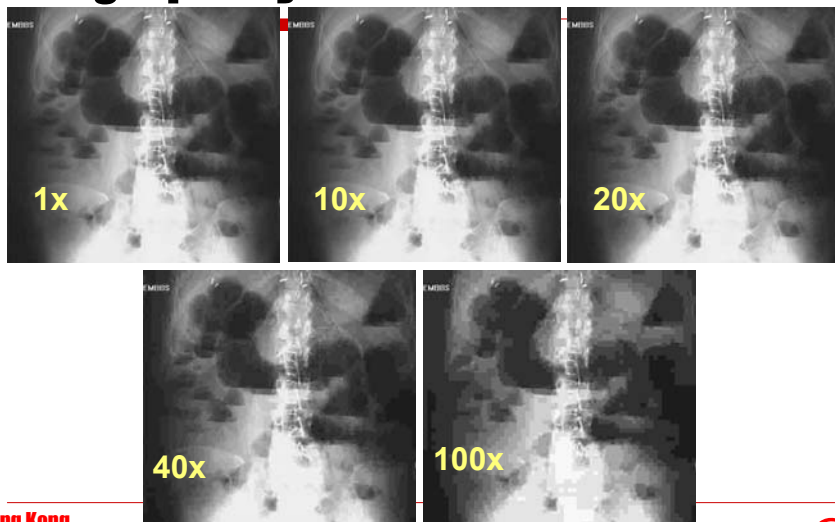
- 160 clinicians
- Several studies
  - Normal
  - Marginal
  - Pathological
- Different compression ratios

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## Image quality

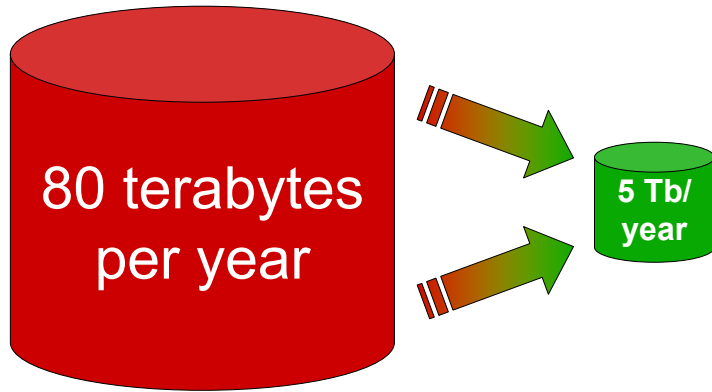
What is the highest acceptable compression ratio?



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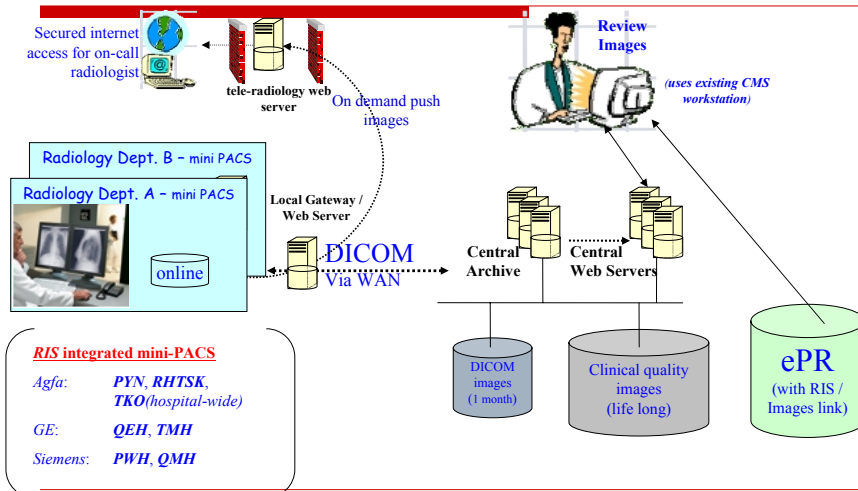
# Data volume



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# Architecture



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HKID: K1001000 Name: PATIENT, 305997(病人) DOB: 01/12/1965 (Exact? Y) Age: 39 Sex: F Death: N

Patient Name  
PATIENT, 305997(病人)

Summary Schedule Latest  
Latest: 1x results

print  
PATIENT, 305997  
Diagnosis  
Procedure  
Clinical Note  
All  
Discharge Note  
AE Note  
Radiology Record  
Radiology Result  
Radiology Appointment  
SARS Report  
SARS Mini Data Set  
Post SARS Clinic  
SARS Specific Lab. Result  
Procedure Record  
ERS  
OTRG  
Functional Outcome  
Rehabilitation Outcome Rep  
Laboratory Result  
Blood Group Result  
Cumulative Common  
Specialty Profile  
Medical  
DM  
Immunology  
Liver  
Renal

Search by Request Date Legend

Request Date Period Request Date Range

Period: All OR From Date: To Date: go reset

HND50000002	10/01/2005	14:02	XRAY	Clavicle	AHN
HND50000001	10/01/2005	12:39	XRAY	AC joint	AHN
No case no	07/01/2005	14:55	CT	Shoulder plain	AHN
No case no	07/01/2005	14:55	CT	Shoulder +con.	AHN
No case no	07/01/2005	14:53	XRAY	AC joint	PWH
No case no	07/01/2005	14:52	XRAY	Chest	NDH
No case no	07/01/2005	14:52	XRAY	Chest + Ba	NDH

Report copy find

Last Updated Date: 10/01/2005 17:19 Last Endorsed Date: 10/01/2005 17:19

Content:

URGENT PLAIN CT BRAIN.

Clinical History:  
Head injury with LOC and vomiting. (history from ePR: patient has history of NPC and Ca Lung).

Technique:  
- 5mm non-contrast axial CT scans of the posterior cranial fossa.  
- 10mm non-contrast axial CT scans of the rest of the brain.

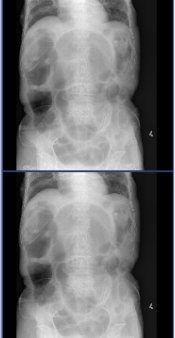
Findings:  
There is a hyperdense subdural haematoma in the left frontoparietotemporal region. It measures 9mm in thickness.  
There is mild mass effect with ipsilateral sulcal, ventricular effacement and mild midline

1st Endorsed By: RIS User for DEMO 2nd Endorsed By:  
1st Endorsed Date: 10/01/2005 17:19 2nd Endorsed Date:

Centricity Enterprise Web V2.1 - Microsoft Internet Explorer

PATIENT, 305997  
ID: K1001000

Abdomen  
4/11/2004 12:36:37 1 series  
abdomen non-bucky 2 images

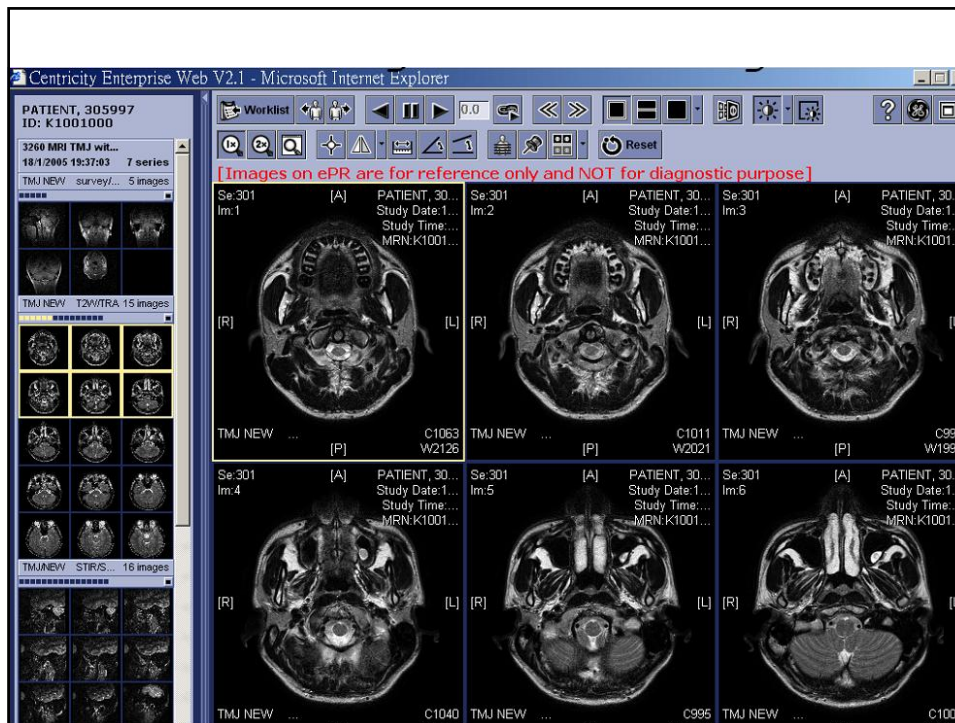


[Images on ePR are for reference only and NOT for diagnostic purpose]

Studies on Losless ARCH

Loc	Patient Name	Mod	Study Description	Study Date	Study Time
<input type="checkbox"/>	PATIENT, 305997	CT	Abdomen plain, Abdomen+ con.	3/11/2004	14:00:03
<input type="checkbox"/>	PATIENT, 305997	CR	Abdomen	4/11/2004	12:36:37
<input type="checkbox"/>	PATIENT, 305997	CT	Thorax+ con.	18/11/2004	10:01:01
<input type="checkbox"/>	PATIENT, 305997	CR	Abdomen	26/1/2005	14:34:05
<input type="checkbox"/>	PATIENT, 305997	CT	Right shoulder	7/4/1995	11:28:04
<input type="checkbox"/>	PATIENT, 305997	CT	Spine fracture	5/1/2005	17:17:23
<input type="checkbox"/>	PATIENT, 305997	RG	Fracture radius	7/1/2004	12:00:00
<input type="checkbox"/>	PATIENT, 305997	MR	3260 MRI TMJ with contrast	18/1/2005	19:37:03
<input type="checkbox"/>	PATIENT, 305997	CT	Abdomen^2_Pancreas	14/1/2005	12:59:42
<input type="checkbox"/>	PATIENT, 305997	CT	Extremities^1_FootAnkle	11/1/2005	15:30:25
<input type="checkbox"/>	PATIENT, 305997	RG	Thorax	7/1/2004	
<input type="checkbox"/>	PATIENT, 305997	CR	Ped chest AP (pneumo thorax)	5/1/2005	17:11:00
<input type="checkbox"/>	PATIENT, 305997	CT	Thorax plain, Thorax+ co	18/11/2004	20:27:47
<input type="checkbox"/>	PATIENT, 305997	CR	Ped chest AP (pneumo thorax)	5/1/2005	17:07:00

Results: 14



## Benefits

- Clinician friendly access to images
  - From any clinical workstation
- Access to all of a patient's images
  - Lifelong
  - From all sites
- Remote access to images
- Possibility of reducing film printing
- Offline image backup
- Sharing of ePR -> sharing of images
- Affordable



## Other images

- Computer generated images
  - Print images
- Digital photographs
- Scans



Hospital Authority Tung Wah Hospital Endoscopy		Case No: RM 95000013 Name: PATIENT, 28587 病人 MRN: DOB: 03/07/1932		HKID: A282552(2)	
Sex : F Age: 70y Ward: E1 Specialty: HASC				(Case No)	
Bronchoscopy					
Exam. Date/Time: 21/02/2000 11:45 Condition: Elective Endoscopist / Nurse: [C] EDS CHAN T M [E] YEUNG TAK TIM <small>( [C] = Chief, [S] = Supervisor, [E] = Endoscopist, [N] = Nurse )</small> Medication: Nil					
<u>Indication / History</u> Diffuse CXR abnormality					
<u>Finding and Endoscopic Procedure</u> finding					
<u>Endoscopic Diagnosis:</u> Rupture colon, non-traumatic (569.89)					
<u>Procedure:</u>					



**Public-Private Interface – Electronic Patient Record Sharing Pilot Project**  
 公私營醫療合作 - 醫療病歷互聯試驗計劃

## Logon

User ID:

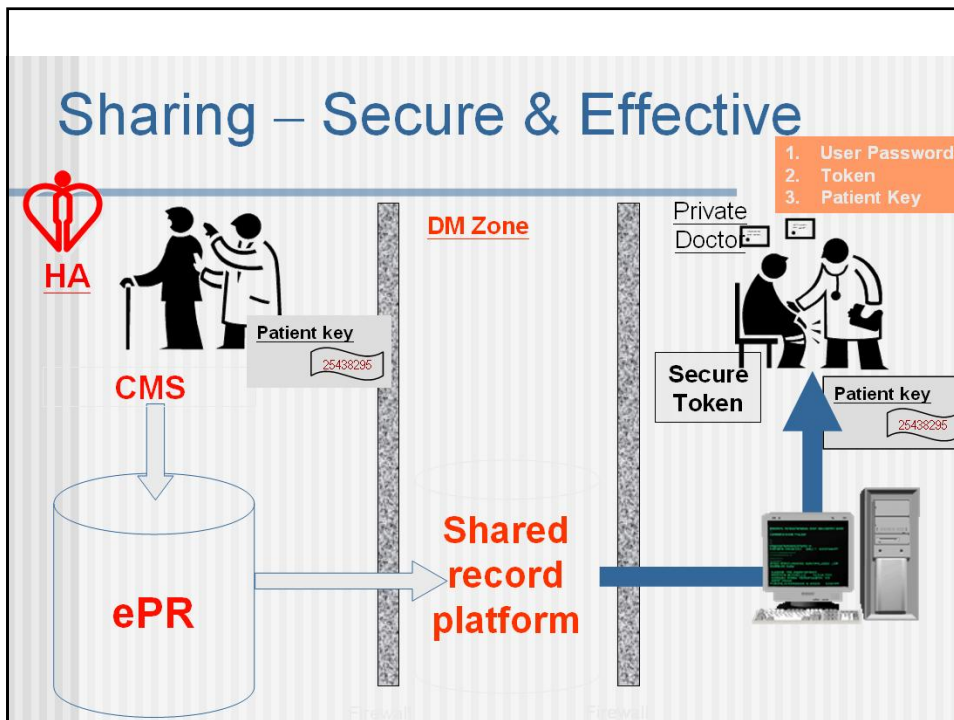
Log in to access this protected resource. If you don't remember your login information, contact your help desk or administrator.

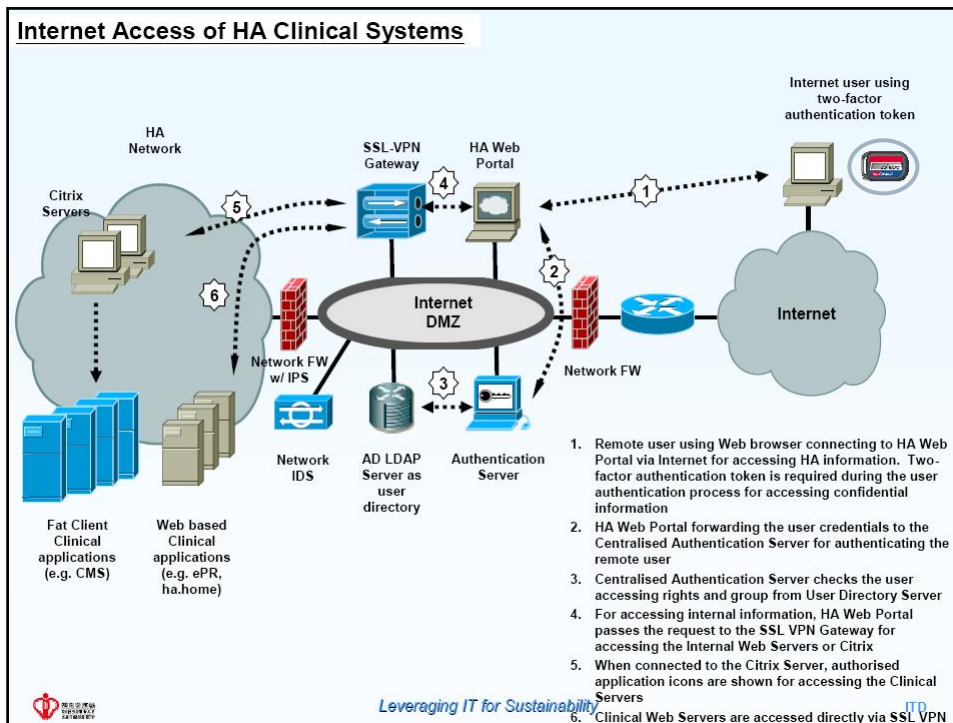
醫院管理局  
HOSPITAL AUTHORITY

*Notice and Disclaimer for HA PPI-ePR Sharing Pilot Project*

Hong Kong Hospital Authority  
 147B Argyle Street, Kowloon, Hong Kong Special Administrative Region, PRC.

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## Privacy Measures

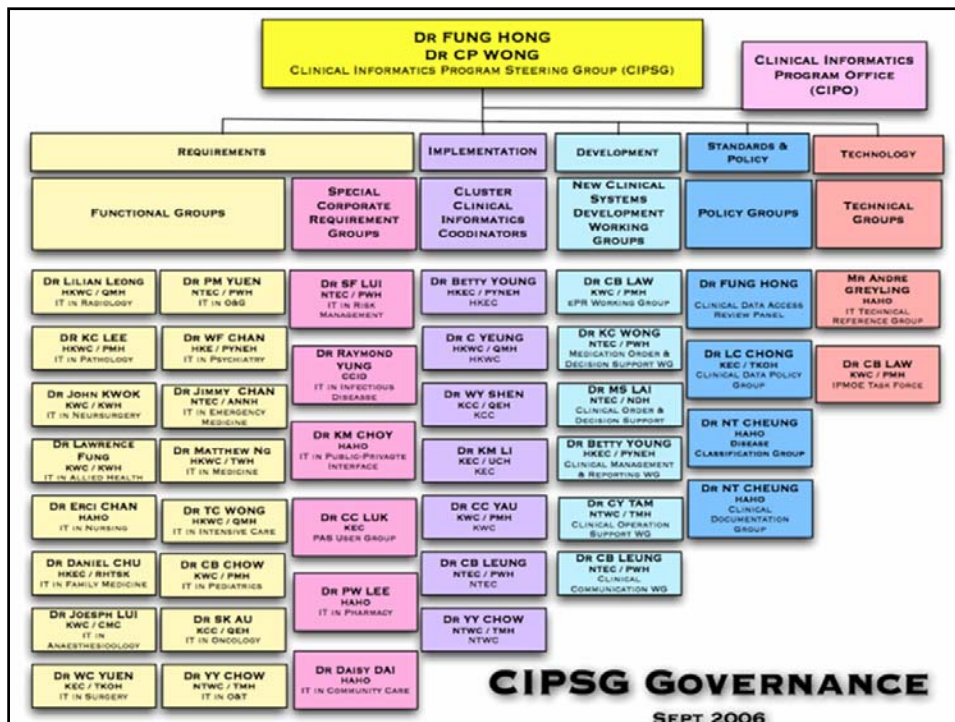
- Role-based restriction of view authority of users
- 2-factor authentication tools
- SMS codes and notifications
- Need to know / patient under care basis
- Detailed audit trail logging
- Privacy ordinance

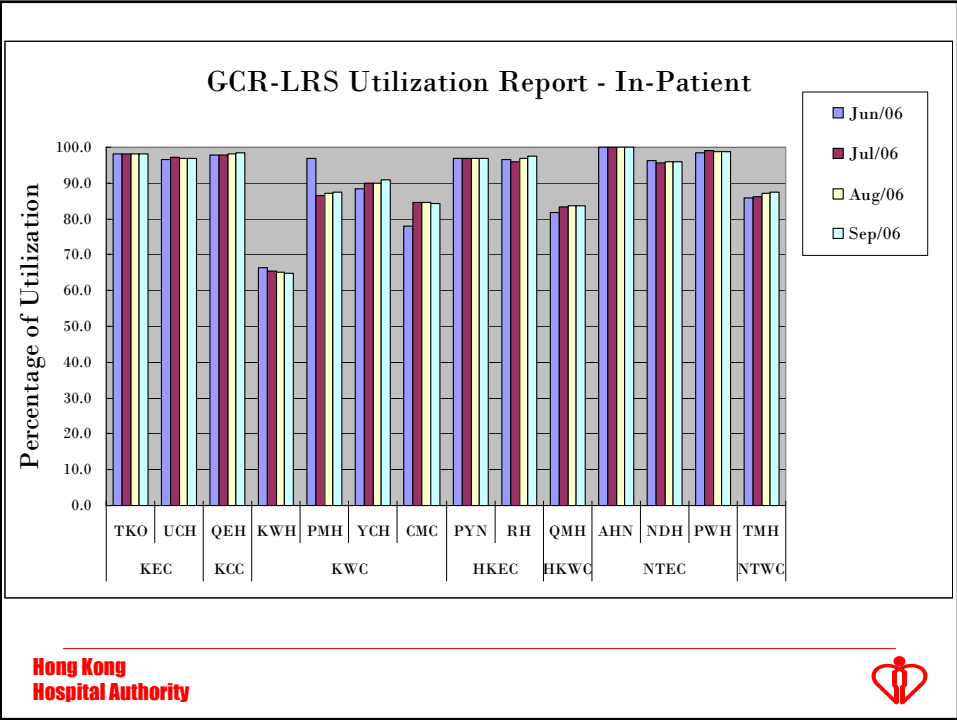
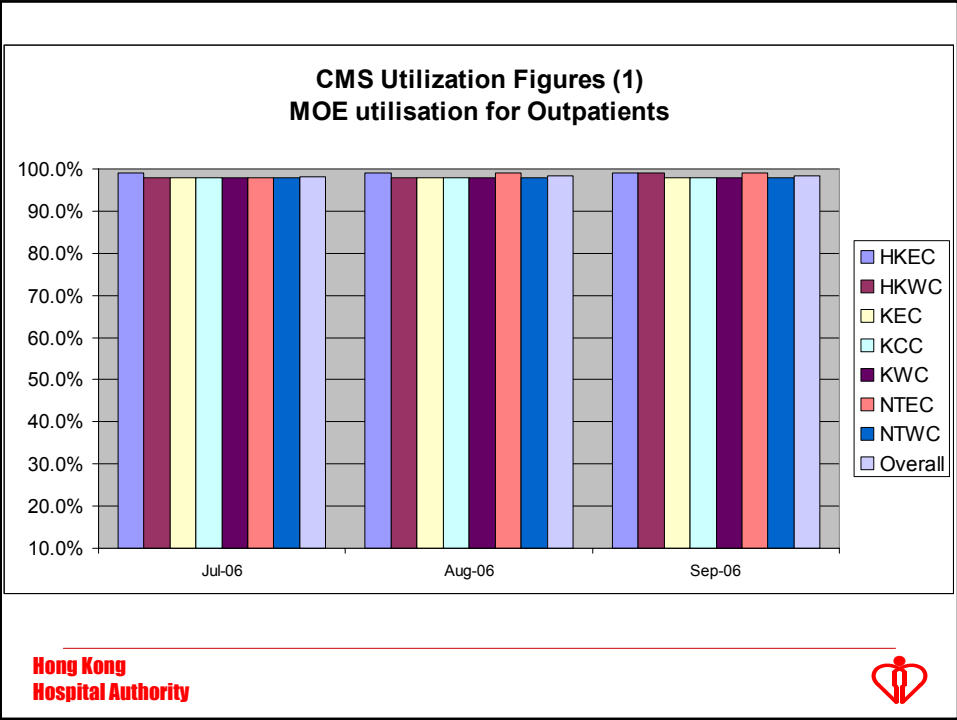




# Critical Success Factors

- Clinicians engagement
- Requested by the clinicians
- Designed by the clinicians
- Built for the clinicians
- Used by the clinicians
- Governed by the clinicians





## Other Success Factors

- Unique citizen identity card
- Non-Big Bang Approach
- Home-built system
- Careful implementation policies
- Pilots sites
- Dedicated User training teams

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## International recognition



### Best in Class Around The World

Project Implementation/ Scope Management	Hong Kong	<ul style="list-style-type: none"> <li>• Focused Uniform Clinical Information Systems Project</li> <li>• Focus on Ancillary Integration</li> <li>• Probably not replicable anywhere else in the world</li> </ul>
Components/ Innovations	United States (Kaiser)	<ul style="list-style-type: none"> <li>• Advanced Models For Clinical Documentation</li> <li>• CMV and sophisticated rules engine management.</li> </ul>
Security/Privacy	Canada, UK Brazil, US	<ul style="list-style-type: none"> <li>• Clear Regulations with Enforcement Mechanism</li> <li>• Active Engagement of Consumer Advocacy Groups</li> <li>• Smart Card Solutions For Authentication except in U.S.</li> </ul>

Dave Garts  
(Gartner Group)



## Awards won

- 2004 Stockholm Challenge (Health)
- IT Excellence 2005
- APICTA 2005



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## Patient benefits

- Whole medical record available at point of care anywhere
- Saving money for repeated tests
- Saving lives by providing real-time and accurate information for clinical decisions
- Ensuring security and confidentiality of patient data

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## Clinician benefits

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- More efficient clinical practice
  - No need to search for data
- Make decisions with comprehensive clinical information
- Avoid errors associated with paper records
- Access data and images at home or remote sites for expert consultations



## The health system benefits

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- More efficient and cost effective quality health service
- A massive clinical database for planning and research



## Summary

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- A pragmatic approach to corporate image distribution
- Leveraging existing infrastructure and systems
- Clinicians engagement is essential
- Issues
  - Clinical suitability
  - Compression ratios
  - Workflow issues (less film?)
  - Other image types



## Acknowledgements

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- Dr Wing Nam WONG, Manager (Health Informatics), Hospital Authority
- Mr Anthony CHEUNG, Senior Systems Manager, IT Division, Hospital Authority
- Dr NT CHEUNG, Executive Manager (Health Informatics), Hospital Authority

