Anesthesia Information Management System in Cardiac Surgery

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Abstract

A new Anesthesia Information Management System has been developed at Heart Hospital of G. Monasterio CNR – Tuscany Region Foundation in Massa. It is specialized in recording anesthesia-related perioperative patient data during cardiac surgery on either adult or pediatric patients. The system was aimed at integrating all patient data partly filled in by the operator, partly SQL-retrieved from the Hospital Information System, and partly gathered, by HL7, from Operating Room instrumentation. Software was developed in Java, achieving reliability and cross-platform capability. Operation reports for surgeon's convenience are automatically created in the HIS medical record at start of surgery. HTML reports are provided and printed out. AIMS was introduced in ORs since March 2011, using medical-grade computers close to patient bed. This system could be potentially deployed to other institutions, not limiting to cardiac interventions.

1. Introduction

During the last 15 years the Hospital Information System (HIS) was developed at National Research Council (CNR), Institute of Clinical Physiology (IFC), first in Pisa for the integration of resources in Cardiology and later at G.Pasquinucci Heart Hospital in Massa, specialized in Cardiology and Cardiac Surgery (both adult and pediatric). In 2007 IFC-CNR health-care activities converged into the "G. Monasterio Foundation" (FGM) by the joint effort of CNR, Tuscany Region and Universities (Fig.1). Given the amount of heterogeneous sources of patient data, both administrative and clinical, integration was crucial to allow comprehensive medical decision making, effective care planning and proper resource control. A networked information systems was implemented, based on three levels of data archiving (administration, clinical system and functional units, i.e. diagnostic laboratories, care units, Operating Rooms) and on two modalities for data exchange (middleware data integration into the central clinical database ARCA and Web distribution of health care information over the HIS network). The computer-network infrastructure, interconnecting GPH with the head institution in Pisa, allows achieving full access to patient information from any workstation. Secure Web technology was applied for distribution of health care information.

Figure 1. G. Monasterio CNR/Tuscany Region Foundation.

The project of the information system was aimed at collecting, archiving and integrating all data related to patient care, from the visit in ambulatory to hospital admission, diagnostic procedures, cardiac surgery intervention and finally discharge and follow-up (Fig.2). The different sources of patient information were integrated by middleware into the central hospital database (ARCA) which represents the clinical

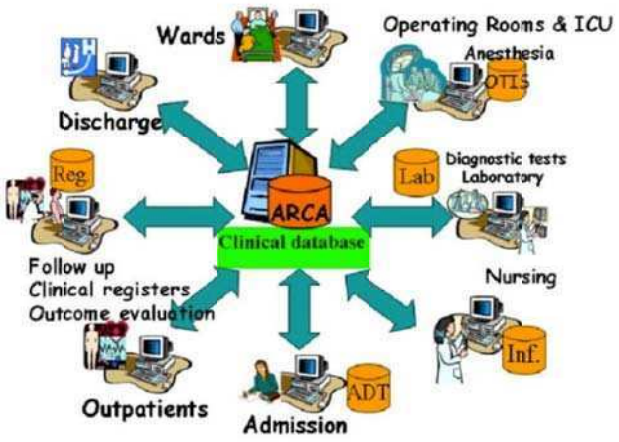


Figure 2. Patient data flows in cardiac surgery

repository. Thus, transition from paper-based towards electronic medical record (EMR) was achieved.

2. Anesthesia information system

A commercial system [1,2], integrated with HIS, was used during last ten years for documentation of anesthesia procedure during cardiac surgery operations.

The new AIMS has been fully developed at the Heart Hospital in Massa. It is specialized for recording anesthesia-related perioperative patient data during cardiac surgery on either adult or pediatric patients.

The AIMS is aimed at integrating patient data (clinical, instrumental and administrative) partly filled in by operator (anesthetist or anesthesia technician) through the Graphical User Interface, partly SQL-retrieved from Hospital Information System (Oracle), repository of patient electronic medical records, and partly gathered, by HL7 [3], from Operating Room instrumentation (monitors, anesthesia equipment and blood gas analyzer) (Fig.3).

Features

- Anesthesia database integrated with SIO (ARCA) (Oracle).
- Login to anesthesia record by personal account
- Software in Java, reliable and cross-platform.
- System specifications by anesthesia personnel.
- GUI, designed to ergonomics, divided into modules, according to tasks.
- Operation report for surgeon's convenience automatically created in HIS EMR .

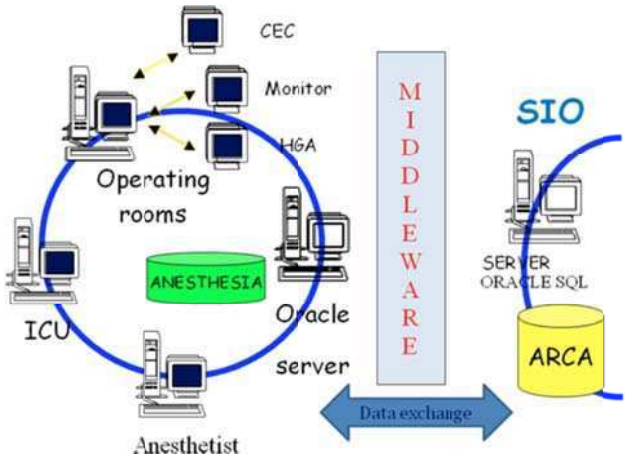


Figure 3. Patient data integration in anesthesia.

It was crucial to define requirements by interaction with anesthetists and later by cycles of test, revising and correction. GUI, designed to better ergonomics, was divided into modules, each one corresponding to a task or phase of anesthesia procedures. Specific forms are provided for documentation of induction phase, for recording staff, drug administrations (bolus or drip), fluid or blood administrations or losses, and any event of interest, for displaying physiological parameters, for echocardiography reporting (Fig.4). List of anesthesia-related information, fluid balance, lists or trends of physiologic, blood, ventilation, coagulation or monitoring parameters are represented. Counters for timing of main phases (e.g. anesthesia, surgery, ECC) are provided. Operation reports for surgeon's convenience are automatically created in the HIS medical record at start of surgery. HTML reports are created, retrieving data from anesthesia database (Oracle), and printed out: "the anesthesia report", i.e. the medical and legal document, and the "ICU report" addressed to personnel taking care of operated patient.

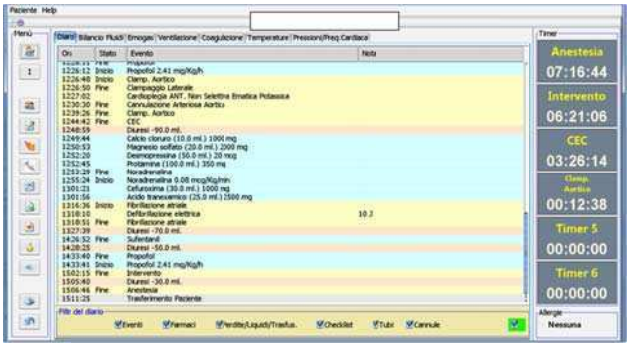


Figure 4. Main Graphical User Interface of AIMS: the diary *in the middle* and the event counters *on the right*, the tags for access to data views *on the top*, the diary filters *on the bottom.*

Graphical User Interface (data-entry)

Structured data entry (*by buttons on the left of the main interface*) is provided:

- patient data characterization and OR set up
- induction phase (from intubation to check lists)
- staff (anesthetists, technicians, nurses, surgeons)
- events (surgery, CEC,...)
- physiological parameters
- drug administrations (bolus/drip): computing dosages and quantities (Fig.6)
- fluid balance
- echocardiography and anesthesia reports

Graphical User Interface (information display)

Forms (*accessing by tags on the top of main interface*) for the representation of (Fig.5):

- list of anesthesia-related information (the diary)
- fluid balance.
- blood gas tests, ventilation, temperatures, blood pressures, heart rate, coagulation and monitoring parameters and/or trends (Fig.7).

Counters for timing of main phases (e.g. anesthesia, surgery, CEC)

Printing

HTML reports are created, SQL retrieving data from anesthesia database and printed out: "the anesthesia report", i.e. the medical and legal document, and the "ICU report" addressed to personnel taking care of operated patient.

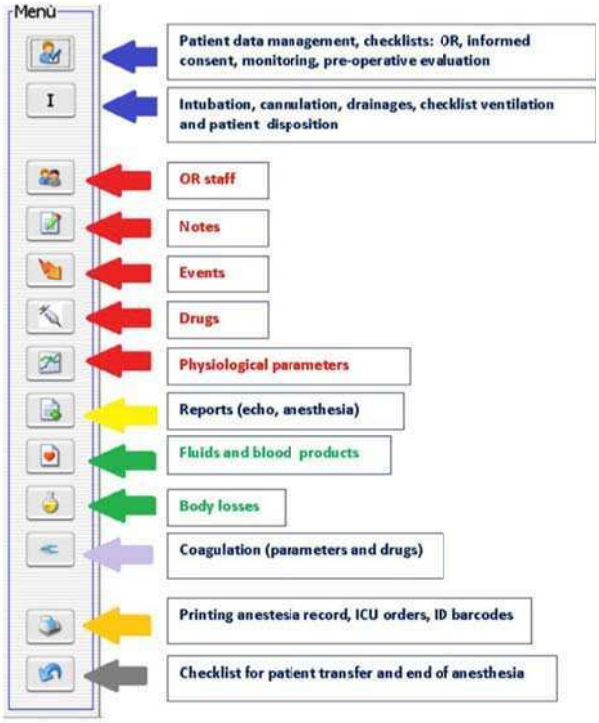


Figure 5. Data-entry, printing and log-out.

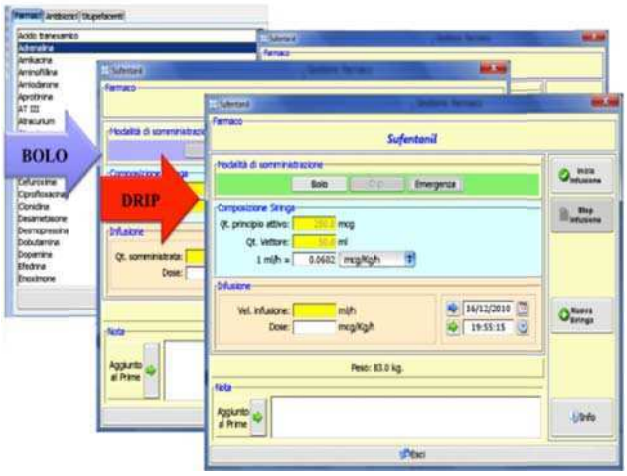
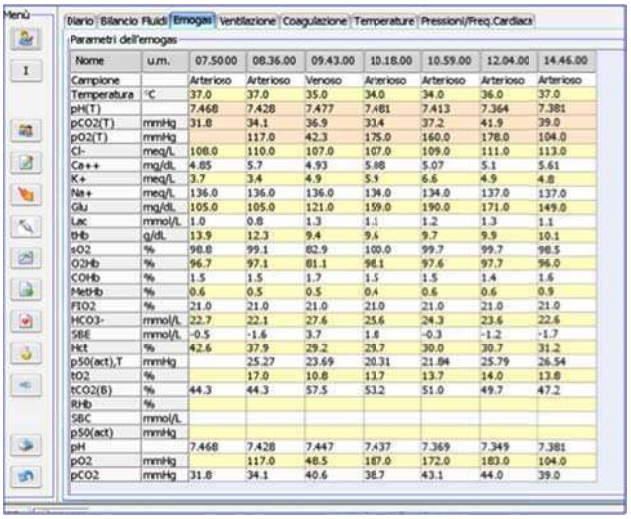


Figure 6. Recording and computing drug administrations (bolo and drip).



Nome	u.m.	07.50.00	08.36.00	09.43.00	10.18.00	10.59.00	12.04.00	14.46.00
Campione		Arterioso	Arterioso	Venoso	Arterioso	Arterioso	Arterioso	Arterioso
Temperatura	°C	37.0	37.0	35.0	34.0	34.0	36.0	37.0
pH(T)		7.468	7.428	7.477	7.481	7.413	7.364	7.381
pCO2(T)	mmHg	31.8	34.1	36.9	33.4	37.2	41.9	39.0
pO2(T)	mmHg		117.0	42.3	175.0	160.0	178.0	104.0
Cl-	meq/L	108.0	110.0	107.0	107.0	109.0	111.0	113.0
Ca++	mg/dL	4.85	5.7	4.93	5.88	5.07	5.1	5.61
K+	meq/L	3.7	3.4	4.9	5.9	6.6	4.9	4.8
Na+	meq/L	136.0	136.0	136.0	134.0	134.0	137.0	137.0
Glu	mg/dL	105.0	105.0	121.0	159.0	190.0	171.0	149.0
Lac	mmol/L	1.0	0.8	1.3	1.1	1.2	1.3	1.1
tHb	g/dL	13.9	12.3	9.4	9.6	9.7	9.9	10.1
sO2	%	98.8	99.1	82.9	100.0	99.7	99.7	98.5
O2Hb	%	96.7	97.1	81.1	98.1	97.6	97.7	96.0
COHb	%	1.5	1.5	1.7	1.5	1.5	1.4	1.6
MetHb	%	0.6	0.5	0.5	0.4	0.6	0.6	0.9
FIO2	%	21.0	21.0	21.0	21.0	21.0	21.0	21.0
HCO3-	mmol/L	22.7	22.1	27.6	25.6	24.3	23.6	22.6
SBE	mmol/L	-0.5	-1.6	3.7	1.8	-0.3	-1.2	-1.7
Hct	%	42.6	37.9	29.2	29.7	30.0	30.7	31.2
p50(act),T	mmHg		25.27	23.69	20.31	21.84	25.79	26.54
tO2	%		17.0	10.8	13.7	13.7	14.0	13.8
tCO2(B)	%	44.3	44.3	57.5	53.2	51.0	49.7	47.2
RHb	%							
SBC	mmol/L							
p50(act)	mmHg							
pH		7.468	7.428	7.447	7.437	7.369	7.349	7.381
pO2	mmHg		117.0	48.5	187.0	172.0	183.0	104.0
pCO2	mmHg	31.8	34.1	40.6	38.7	43.1	44.0	39.0

Figure 7. Blood gas reports are achieved via HL7 from the OR analysis equipment.


FONDAZIONE TOSCANA GABRIELE MONASTERIO
Ospedale del Cuore "G.Pasquinucci" - Massa
U.O.C. ANESTESIA E TERAPIA INTENSIVA Direttore Dott. Paolo Del Sarto

SALA 1

CARTELLA ANESTESIA

Gruppo sanguigno: **0 pos.**

DATI CLINICI

STAFF

PROCEDURE

MONITORAGGIO

ASSETTO PAZIENTE

APERTI

BILANCIO FLUIDI

VENTILAZIONE

	Modalità vent.	Pressione max. (cm/H2O)	Freq. resp. (atti/min)	Vol. Corrente (ml)	Vol Min. (ml)	FiO2 (%)	PEEP (cm/H2O)
09:56	VC	15	12	550	6,7	60	-
10:42	Circolazione Extracorporea	-	-	-	-	-	-
12:30	VC	17	12	600	7,2	60	4

EMOGASANALISI

	A/V	T (°C)	pH(T)	pCO2(T) (mmHg)	pO2(T) (mmHg)	Ca++ (mg/dL)	K+ (meq/L)	Na+ (meq/L)	Glu (mg/dL)	Lac (mmol/L)	sO2 (%)	FiO2 (%)	HCO3- (mmol/L)	cBase(Ecf,ox) (mmol/L)	Hct (%)
09:23	A	37	7,338	45,1	118	1,23	4	138	96	,6	98,2	21	23,6	-1,4	39,7
10:56	A	34	7,362	41,2	177	1,13	4,2	138	107	,7	99,4	21	23,8	-1,4	30,7
11:26	A	34	7,378	37,1	196	1,14	5	137	130	,8	99,4	21	22,3	-2,7	31,7
11:56	A	34	7,374	36,8	191	1,14	5,3	137	150	1,1	99,3	21	21,9	-3,1	31,1
12:23	A	36	7,364	36,1	199	1,15	5,6	138	163	1,5	99,4	21	20,6	-4,1	30,7
12:48	A	37	7,285	46,1	158	4,96	4,4	138	148	1	99	21	21,3	-4,3	30,7

Figure 8. Printout of anesthesia record.

3. Conclusions

The new AIMS has been introduced for use in ORs since March 2011, using medical-grade computers close to patient bed. Bloog gas analyzers (Radiometer) were integrated by HL7v2.

HL7v3 data integration with monitoring (Fukuda) and CEC (Stocker) systems is under development.

This system, adopting advanced IT solutions (Java, HL7, database relational), could be potentially deployed to other institutions, not limiting to cardiac interventions.

Acknowledgements

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[3] HL7: www.hl7.org/

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