



## Assessment of the Level of Optimisation of the Interventional Cardiology Practice - the Sentinel Project

Y. Jankowski, R. Padovani<sup>1</sup>, K. Faulkner<sup>2</sup>, E. Vano<sup>3</sup>, H. Bosmans<sup>4</sup>, A. Dowling<sup>5</sup>, C. Bochou<sup>6</sup>, V. Tsapaki<sup>7</sup>, A. Kosunen<sup>8</sup>, C. Milu<sup>9</sup>, J. Vassileva<sup>10</sup>, D. Salat<sup>11</sup>, M.R. Malisan<sup>1</sup>, C. Foti<sup>1</sup>, F. Bonutti<sup>1</sup>, E. Moretti<sup>1</sup>, A. Trianni<sup>1</sup>

Lodz, Poland; <sup>1</sup>Udine, Italy; <sup>2</sup>Newcastle, UK; <sup>3</sup>Madrid, Spain; <sup>4</sup>Leuven, Belgium;  
<sup>5</sup>Dublin, Ireland; <sup>6</sup>Luxembourg; <sup>7</sup>Athens, Greece; <sup>8</sup>Helsinki, Finland; <sup>9</sup>Bucarest, Romania; <sup>10</sup>Sofia, Bulgaria; <sup>11</sup>Trencin, Slovakia

WC 2006, Seoul, 31 August 2006



## Objectives for the optimisation of interventional cardiology

- To compare patient and staff exposure and equipment performance in a sample of hospitals in 12 European countries
- To identify Reference Levels for cardiac procedures
- To update Quality Criteria for cardiac images and to suggest technical factors for an optimised exposure.

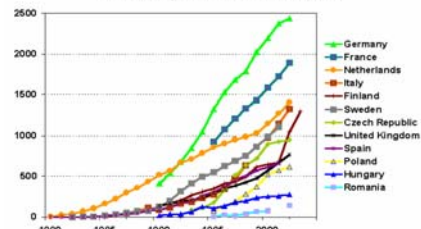
## Frequencies of cardiac procedures in European countries



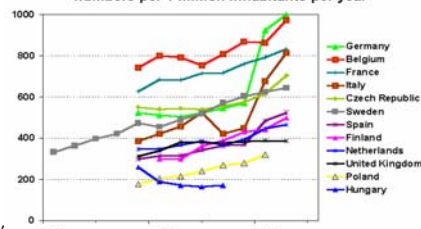
- For PTCA:
  - The frequency varies from 100 to 2500 per year and per 1 million inhabitants
  - About 700,000 PTCA procedures are performed every year in the European Union
- There is a rapid increase of the frequency for all procedures

(source: European Society of Cardiology)

Time trends in the annual use of PCI numbers per 1 million inhabitants



Time trends in the use of Pacemakers numbers per 1 million inhabitants per year

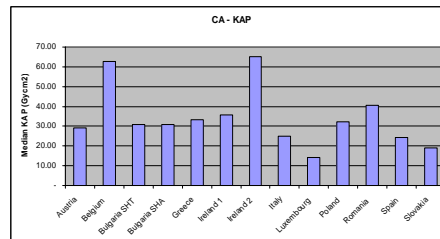
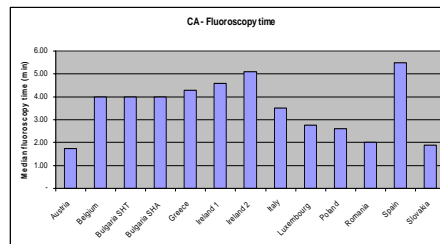


WC2006, Seoul 31 /

## Patient exposure



- Coronary Angiography:
  - Median fluoroscopy time varies from 2 to 5 minutes
  - Median KAP varies from 15 to 65 Gy $\text{cm}^2$
  - Some are teaching hospitals where highest fluoroscopy time are justified
  - Highest doses occur where high frame rates in image acquisition is used



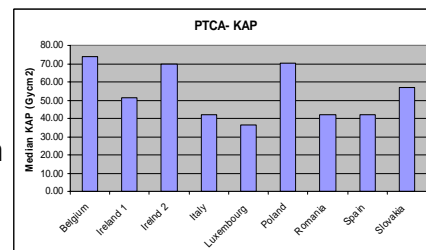
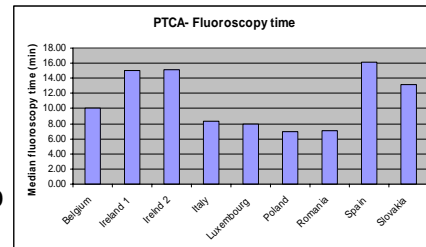
WC2006, Seoul 31 August 2006

4



## Patient exposure

- Coronary Angioplasty:
  - Median fluoroscopy time varies from 7 to 15 minutes
  - Median KAP varies from 35 to 75 Gy $\text{cm}^2$
  - Some are teaching hospitals where highest fluoroscopy time are justified
  - Complexity of procedures can account for differences in FT and KAP values



WC2006, Seoul 31 August 2006

5



## Patient exposure summary

- Patient exposure differs for a factor of 4 for CA and a factor of 2 for PTCA
- CA procedures are less optimised compared to PTCA where the complexity of the pathology plays an important role in determining the patient exposure

WC2006, Seoul 31 August 2006

6

## Performance of angiography systems



- Level of performance are evaluated comparing:
  - Doserates in fluoroscopy and imaging modes
  - KAPmeter calibration

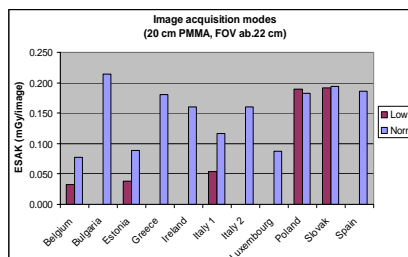
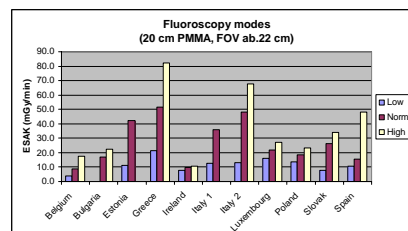
WC2006, Seoul 31 August 2006

7

## Equipment performance: doserates



- Kerma rate at the entrance of a 20 cm PMMA phantom:
  - in fluoro Low varies from 4 to 28 mGy/min (a factor of 7)
  - in imaging Normal mode from 70 to 210  $\mu$ Gy/image (a factor of 3)
- There is not correlation between patient dose and equipment doserates



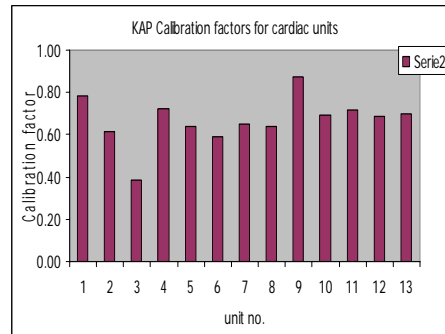
WC2006, Seoul 31 August 2006

8

## Equipment performance: KAP calibration intercomparison



- Intercomparison exercise has shown that KAP values must be corrected to take into account table and mattress attenuation.
- Calibration factors ranged from 0.4 to 0.9 for the different centres



WC2006, Seoul 31 August 2006

9

## Image quality of Coronary Angiography procedures



- Quality Criteria for CA procedures have been developed by former DIMOND group
- 3 CA studies per center have been collected and a panel of cardiologists will assess clinical and technical quality of the studies
- Suggestions for optimised procedures will be derived

WC2006, Seoul 31 August 2006

10

## Clinical criteria for RCA projections



Clinical criteria based on the level of visualisation of anatomical features.

Example for the Right Coronary Angiography:

- 1) *Visually sharp reproduction of the origin, proximal, mid (especially the crux region) and distal portion in at least two orthogonal views, with minimal foreshortening and overlap*
- 2) *Visually sharp reproduction of side branches  $\geq 1.5$  mm in at least two orthogonal views, with minimal foreshortening and overlap. The origin should be seen in at least one projection*
- 3) *Visually sharp reproduction of lesions in vessels  $\geq 1.5$  mm in at least two orthogonal views, with minimal foreshortening and overlap*
- 4) *Visualization of collateral circulation when present*
- 5) *.....*

## Technical criteria for RCA projections





Technical criteria based on technical aspects of the procedure.

Example for the Right Coronary Angiography:

- 1) *Simultaneous and full opacification of the vessel lumen at least until the first flow-limiting lesion (in general ~ 90-95% by visual estimation)*
- 2) *Performed at full inspiration if necessary to avoid diaphragm superimposition or to change anatomic relationship (in apnoea in any case)*
- 3) *Arms should be raised clear of the angiographic field*
- 4) *Panning should be limited. If necessary, pan in steps rather than continuously, or make subsequent cine runs to record remote structures*
- 5) *When clinical criteria 1-4 have been fulfilled, avoid extra projections (mainly LAO semi-axial)*

A scoring system is adopted to quantify image quality of a study

**RIGHT CORONARY ANGIOGRAPHY**

1. arms outside the x-ray beam	yes	<input checked="" type="checkbox"/> 2	no	<input type="checkbox"/> 0
2. apnoea <sup>1</sup>	yes	<input checked="" type="checkbox"/> 5	no	<input type="checkbox"/> 0
3. full opacification of the vessel lumen <sup>2</sup>	yes	<input type="checkbox"/> 10	no	<input checked="" type="checkbox"/> 0
4. Panning	present	<input checked="" type="checkbox"/> 0	absent	<input type="checkbox"/> 5

Grade of visualization of vessels walls and/or stenosis with minimal foreshortening and overlap (consider two projections):

	visualization	reproduction	visually sharp reproduction	not applicable
5. origin	<input type="checkbox"/> 1	<input type="checkbox"/> 5	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 0
6. proximal	<input type="checkbox"/> 1	<input type="checkbox"/> 5	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 0
7. mid	<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 10	<input type="checkbox"/> 0
8. distal (pre-crux)	<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 10	<input type="checkbox"/> 0

Grade of visualization of vessels walls and/or stenosis with minimal foreshortening and overlap of the side branches  $\geq 1.5$  mm and/or stenosis (without superimposition of others) including the origin:


	visualization	reproduction	visually sharp reproduction	not applicable
9. PD	<input type="checkbox"/> 1	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 8	<input type="checkbox"/> 0
10. PL1	<input type="checkbox"/> 1	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 8	<input type="checkbox"/> 0
11. PL2	<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 8	<input type="checkbox"/> 0
12. PL3	<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 8	<input type="checkbox"/> 0
13. AM	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 4	<input type="checkbox"/> 8	<input type="checkbox"/> 0
14. Others	<input type="checkbox"/> 1	<input type="checkbox"/> 4	<input type="checkbox"/> 8	<input type="checkbox"/> 0

Visualization of collateral circulation in two orthogonal views<sup>4</sup>

15. good  10      poor  0      not applicable  0

Final evaluation: cine runs have been performed in a way which is:

16. insufficient  0      sufficient  10      redundant<sup>5</sup>  0



31 August 2006 13

## Staff dosimetry and staff exposure

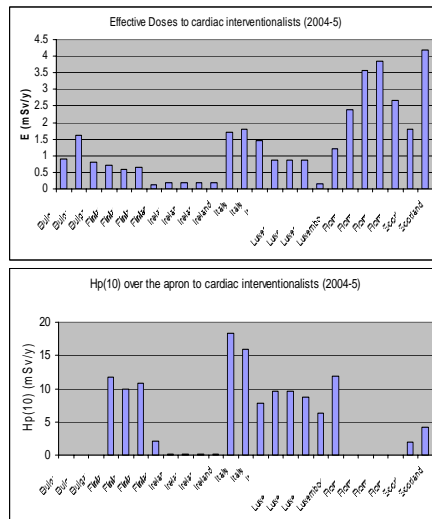


- Very different methodologies are applied:
  - 1 dosimeter worn over the apron
  - 1 dosimeter worn under the apron
  - 2 dosimeters (1 over and 1 under the apron)
- Harmonisation of personal dosimetry is necessary



## Staff exposure

- 2 years exposure data have been collected
- Effective dose and Hp(10) over the apron are reported
- Individual annual effective doses from 0.2 to 4 mSv are reported (factor of 20)
- Different levels of staff protection are adopted



WC2006, Seoul 31 August 2006

15



## Conclusions (I)

- Patient exposure:
  - Patient exposure varies for a factor of 4 for CA and a factor of 2 for PTCA
  - CA procedures are less optimised compared to PTCA where the complexity of the pathology plays an important role in determining the patient exposure
  - Reference Levels assessment are required to help patient exposure optimisation
- Equipment performance:
  - in fluoro Low doserates differ for a factor of 7, in imaging for a factor of 3
  - Proper maintenance, calibration and mode selection is mandatory
  - KAPmeter calibration taking into account table and mattress attenuation is required
- Recommendation for optimised procedures is necessary
- Staff exposure:
  - Harmonisation of personal dosimetry is necessary
  - Harmonisation of staff protection is necessary

WC2006, Seoul 31 August 2006

16



## Conclusions (II)

- Poor level of optimisation is recognised
- Frequent evaluation of the level of optimisation (procedures, patient, staff and equipment) are necessary
- Proper training of staff in radiology imaging and radiation protection methods are mandatory
- External audit must also be considered.

WC2006, Seoul 31 August 2006

17

**DIMOND CONSORTIUM**

Home SENTINEL Project Documents Events Info Consortium DIMOND III Links Private

### SENTINEL Project

#### Safety and Efficacy for New Techniques and Imaging using New Equipment to Support European Legislation

The SENTINEL project will coordinate a programme of research across a consortium of partners from sixteen European Union member states, four candidate member states.

**News and Documents**

- **Workshop on Digital Mammography**  
Leuven, Belgium, 31 March-1 April 2006  
*Training material downloadable*
- **International meeting on: Advances in Patient Dosimetry and Quality Control in Interventional Radiology: The SENTINEL European Programme**  
Madrid, Spain, 21-22 April, 2006  
*Training material downloadable*
- **Expert Training Course on Digital Radiography**  
Trier, Germany, 11-15 Feb 2006  
*PPT presentations in private area*
- **Training Course on Digital Radiography**  
Trier, Germany, 16 Feb 2006  
*Training material download*
- **SENTINEL 3rd Coordination Meeting**  
Trier, Germany, 17-19 February 2006  
*PPT available in private area*
- **Workshop "Radiation Protection in Medicine: Past, Present and Future Challenges"**  
Nofel's Institute of Occupational Medicine  
Lodz, Poland, 26th October 2005  
*Training material downloadable*
- **SENTINEL 2nd coordination meeting**  
Lodz, Poland, 27-29 October 2005  
*PPT presentations in private area*
- **WP 6 Meeting**  
Dublin, Ireland, 22-23 July 2005  
*Minutes & PPT presentations in private area*

**Programme of SENTINEL Meetings & Actions**

- **SENTINEL Coordination Action Project 4th Coordination Meeting**  
Budapest, Hungary, 7-8 July 2006
- **Training Course on Interventional Cardiology**  
Budapest, Hungary, 5-6 July 2006
- **Training Course on Interventional Radiology and Cardiology**  
Budapest, Hungary, 12-13 October 2006
- **Workshop on DEXA: Action & Quality Control**  
Nicosia, Cyprus, 25-26 October 2006
- **SENTINEL Ethics Initiative: An Initial Exploration of Some Ethical Issues in Radiology**  
Dublin, Ireland, 26-28 October 2006  
*Draft Programme in Private Area*
- **Digital Mammography Conference**  
York, UK, January 2007
- **Nuclear Medicine Workshop**  
Nicosia, Cyprus, 14 February 2007

**thanks for your attention**

manufacturers from across Europe, have not been sufficiently supported by studies to ensure these new digital imaging devices and techniques are as effective as they might be or give the lowest possible radiation dose.

SENTINEL will look at the safety and effectiveness of the radiological imaging systems involved in almost 90% of examinations performed in Europe. These systems contribute to 60% of the total radiation dose from medical procedures and approximately half of the radiation the public is exposed to from man-made

WC2006, Seoul 31 August 2006