Table 2
Independent Predictors of Prolonged Hospitalization (>4 Days) (Multivariable Analysis, Logistic Regression)

Variable	OR (95%CI)	*P*
Age	1.012 (1.002-1.022)	.017
Friday admission	2.021 (1.349-3.028)	.001
Admission for heart failure	2.398 (1.761-3.265)	<.001
Hemoglobin at admission	0.888 (0.831-0.948)	<.001
Creatinine at admission	1.264 (1.025-1.559)	.029
Three or more diagnostic tests	2.545 (1.712-3.783)	<.001
Stent implantation	0.635 (0.483-0.836)	.001

95%CI, 95% confidence interval; OR, odds ratio.

coronary angioplasty was a protective factor, due to a tendency to perform percutaneous revascularization earlier and more conservatively, which can reduce hospital stay and its associated complications.

Some of the factors related to PH in cardiology, such as age, creatinine, and hemoglobin at admission, are inherent to the population admitted to hospital and cannot be modified, but others, such as Friday admissions, admissions for heart failure, early revascularization strategies, and the performance of multiple tests can be taken into account when planning policies to reduce length of hospital stay. A change in working hours could be proposed (eg, making Saturdays an ordinary working day) as well as encouraging the creation and promotion of heart failure units with resources, or accelerating the performance of diagnostic techniques (or performing them on an outpatient basis), which could reduce the PH rate. One of the limitations of our study is its observational design and therefore data could only be recorded while the patients were in hospital, without correlating PH and the complications of follow-up.

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Initial Results From a National Follow-up Program to Monitor Radiation Doses for Patients in Interventional Cardiology

Resultados iniciales de un programa nacional para el seguimiento de dosis de radiación en pacientes de cardiología intervencionista

To the Editor,

Catheterization techniques are essential in the diagnosis and treatment of certain cardiac diseases, but the ionizing radiation used in some of these procedures is associated with health risks for patients and health care staff alike. The radiation doses should be minimized as far as possible. The impact of interventional techniques on the radiation dose received is not negligible. According to the 2011 activity registry of the Spanish Society of Cardiology Working Group on Cardiac Catheterization,[1] 2998 diagnostic studies and 1368 percutaneous coronary interventions were performed per million population. The Spanish legislation requires individual registration of the radiation dose received in interventional procedures.[2] The International Commission on Radiological Protection recommends that levels of reference doses be established for different fluoroscopy-guided procedures to optimize the doses administered to patients.[3] Reference values should not be applied in an individual manner because due to complexity reasons or the patient's size these could be exceeded. However, if the reference values were exceeded in a large number of patients, corrective actions would need to be taken.

With the aim of investigating and proposing updated reference dosage values for patients undergoing catheterization procedures, the DOCCACI (*DOsimetría y Criterios de Calidad en Cardiología Intervencionista* in Spanish, or *Dosimetry and Quality Criteria in Interventionist Cardiology* in English) group was formed in 2010, under the auspices of the Spanish Society of Cardiology Working Group on Cardiac Catheterization. The list of professionals who constitute the DOCCACI group can be found in the supplementary material that accompanies this article.

Seven public hospitals in 6 different Spanish autonomous communities joined the project. In each center, a catheterization cardiologist and a radiophysicist took on responsibility for providing data on the radiation dose administered to the patients.

The working group was limited initially to the most common procedures, coronary angiography (CA) and percutaneous transluminal coronary angioplasty (PTCA). The PTCA procedures included both those deferred after a prior CA and a CA with PTCA in the same procedure.

The dose indicator most used for patients in interventional techniques is the dose-area product, which is defined as the integral of kerma in air over the radiation field and expressed in units of dose per area, generally in Gy·cm^2. Since 2010, as part of the DOCCACI program, anonymous data have been collected that include the type of procedure, dose-area product, fluoroscopy time, number of sequences, and the total number of cine images acquired. Some of the centers with automatic data collection systems via DICOM connections with the devices have acquired a large amount of data without noting the complexity of the cases. The centers that have manually compiled the data and provided the smallest samples selected the cases with normal complexity.

The reference values were calculated for dose-area product, fluoroscopy time, number of sequences, and the total number of cine images acquired as the third quartile of the medians of the distributions in each center. Using this methodology, all centers had the same statistical weight in the calculation of the reference values.

Table
Most Representative Statistical Values of Dose Received by Patients in Participating Centers

Center	Cases	Median DAP, Gy·cm^2	Median Ft, min	Median N series	Median N images
Coronary angiography					
10	1673	31	7.1	11	805
20	128	30	7.2	9	787
30	83	23	6.1	9	559
40	21	24	–	–	–
50	704	28	6.3	9	726
70	17	33	4.5	7.5	–
100	492	26	3.9	8	467
Provisional reference values		32	6.7	9	800
Percutaneous transluminal coronary angioplasty					
10	2766	67	15	19	1229
20	88	67	17	22	1345
30	90	62	13	24	1095
40	15	42	–	–	–
50	424	53	13	20	1284
70	21	60	13	17	–
100	225	56	10	14	668
Provisional reference values		67	16	21	1300

DAP, dose-area product; Ft, fluoroscopy time.

Information was collected for 2802 CA and 3576 PTCA procedures. The Table shows the medians of the dose-area product, fluoroscopy time, number of series, and number of cine images for each center. The last row presents the provisional reference values.

The provisional reference values obtained by this working group are lower than those published in 2008 by the group coordinated by the International Atomic Energy Agency,[4] which gave reference values of 50 and 125 Gy·cm^2 for CA and PTCA, respectively, compared to 32 and 67 Gy·cm^2 in this study. Other variables were also lower in the Spanish program, such as fluoroscopy time (6.7 vs 9.0 min in CA and 16 vs 22 min in PTCA) or the number of images (800 vs 1000 for CA and 1300 vs 1700 for PTCA). Although the advances in imaging devices technology in the last 10 years could have some impact on the decreases in dose, this has not been observed in published studies. The decreases could be explained by more effective optimization programs and dose recording. Looking at the Table, it can be seen that there are large differences between centers for some of the variables studied, both in the case of CA and PTCA procedures. This suggests that there is still room for optimization.

Follow-up of these aspects of radiologic protection should continue to verify the sustainability of the reference values and ensure that changes in technology are not associated with an increase in the dose that patients receive unless there is a clear clinical benefit. The Catheterization Working Group is committed to continue with this program.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found in the online version available at doi:http://dx.doi.org/10.1016/j.rec.2013.06.012.

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Note

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Do Inappropriate Implantable Cardioverter-defibrillator Shocks Generate Additional Costs?

¿Las descargas inapropiadas de desfibriladores automáticos implantables generan costes adicionales?

To the Editor,

The efficacy of implantable cardioverter-defibrillators in preventing sudden death has been amply demonstrated.[1] However, inappropriate discharge (ID) remains a therapeutic complication with negative consequences for prognosis and quality of life. Undoubtedly, IDs use up health care resources but no studies have attempted to quantify this cost. We present an analysis of the economic cost of ID-related medical attention in our center.

Between 2003 and 2011, we implanted cardioverter-defibrillators in 227 patients. Antitachycardia pacing therapy was programmed with 2 or 3 zones and overdrive pacing therapy. In the follow-up, the electrophysiologist analyzed each arrhythmic event. ID were defined as those applied in situations other than ventricular tachycardia or ventricular fibrillation, as well as in ventricular tachycardia/ventricular fibrillation appearing after inappropriate pacing in supraventricular or sinus tachycardia. Dubious cases were resolved by consensus. Prolonged episodes, which the device considers as more than one, were considered a single clinical episode.

Analysis was based on clinical episodes. We considered costs directly related with the medical attention received for each episode (extra visits to the clinic, emergency room visits, hospitalization, interventions, and length of in-hospital stay). We also determined the possible effect of IDs on the useful life of devices, taking into account that ID episodes can present as multiple shocks when a shock does not revert the cause that triggered it. The items and associated costs were obtained from the relevant regional government of Catalonia decree (SLT/42/2012).[2]

Median follow-up was 2.5 years (0 days to 8.5 years), and 27 patients (11.9%) presented with an ID. In total, 42 clinical ID episodes were recorded. Incidence was 0.08 episodes per patent/year. The most frequent cause was nonventricular tachycardia (66.7%). Overdetection of T waves caused 16.7% of episodes and electrical noise detection, 11.9%. In 19% of episodes, more than 5 shocks were received.

Tables 1 and 2 show resources used in the 42 episodes and their estimated economic cost, grouped as a function of ID cause. Twenty episodes led to medical examinations in the emergency room or outpatient clinics. Another 20 episodes were diagnosed in subsequent routine check-ups. These were single shock episodes, mostly for nonventricular tachycardia. The 2 remaining episodes occurred in patients hospitalized for another cause and the attention they received was not included as a cost. Eight episodes led to hospitalization. Hospitalizations were classified as a function of the diagnosis-related groups (DRG). Seven DRG 115 patients (implantation or replacement of generator or defibrillator electrode) and 1 DRG 544 patient (heart failure with major complications) were hospitalized. The DRG was the criterion used to determine the cost of hospitalization. Mean in-hospital stay was 4.4 days. Seven patients underwent reinterventions with ID, due to broken electrode (3), electrode displacement (2) and T wave overdetection (2). Total expense attributable to these incidents for all 42 episodes was €118 135.

Forty-nine devices were indicated for replacement due to low battery levels, 12 in the ID group and 37 in the non-ID group. Mean device life was 4.2 (2.2) years and 5.2 (1.6) years, respectively (P=.03). Mean device cost of the 227 implantations was €20 810 per unit. The 19.2% reduction in device life represents a mean cost of €3996 per device with ID.

Table 1
Use of Hospital Resources as a Function of Causes of Inappropriate Discharge

ID causes	Episodes	Emergency room	Ambulatory	Admissions	Intervention	Replacement
Rapid atrial fibrillation	12	2	2	0	0	0
Supraventricular tachycardia	11	1	3	0	0	0
Sinus tachycardia	5	3	3	0	0	0
T wave detection	7	1	4	3	2	0
Electrode displacement	3	1	1	2	2	0
Broken electrode	3	3	0	3	3	3
Inhibition therapy failure	1	1	1	0	0	0
Total	42	12	14	8	7	3

ID, inappropriate discharge.