

## GUIDANCE DOCUMENT

# European Heart Rhythm Association Guidance Document on cardiac rhythm management product performance

Angelo Auricchio\*, Michael Gropp, Susanne Ludgate, Panos Vardas, Josep Brugada, and Silvia G. Priori, Writing Committee for the European Heart Rhythm Association Guidance Document on Cardiac Rhythm Management Product Performance

Fondazione Cardiocentro Ticino, Via Tesserete 48, CH-6900 Lugano, Switzerland

Received 22 March 2006; accepted after revision 25 March 2006

### KEYWORDS

Pacemakers;  
Implantable cardioverter-  
defibrillators;  
Field safety corrective  
actions;  
Cardiac rhythm management

## Introduction

The comparatively large number of field safety corrective actions (FSCAs) recently issued by different device manufacturers has attracted attention to cardiac rhythm management (CRM) device performance.<sup>1–4</sup> It has also prompted questions as to the basis for the scientifically proven efficacy of implantable cardioverter-defibrillators, pacemakers, and cardiac resynchronization therapy devices. The broad worldwide media coverage of these FSCAs demonstrates the tremendous interest in CRM products in both the scientific community<sup>5,6</sup> and the lay public.

The European stakeholders such as clinicians, CRM device industry representatives, National Competent Authorities (regulators), and the scientific society including arrhythmia experts and electrophysiologists [European Heart Rhythm Association (EHRA)] gathered recently to discuss these issues. Participants considered how to improve CRM device technology, its performance and adverse event reporting, and market surveillance as well as how to increase the flow of appropriate information from manufacturer to physician and from physician to patient in Europe. Other international scientific groups have discussed or begun similar processes with the intention of presenting recommendations applicable to their own health care and regulatory systems.

Significant differences in clinical practice exist in device monitoring, regulatory requirements, and vigilance

processes between the European Union (EU) and non-EU countries, as well within the EU, which creates a role for EHRA in helping to coordinate dialogue among stakeholders. Moreover, because of well-known differences in regulatory requirements and approval processes, a new CRM product is frequently clinically tested and brought to market much earlier in Europe than elsewhere. Therefore, active monitoring of CRM products in Europe is mandatory and should be conducted independently from other international monitoring or registry activities, although data sharing is highly desirable. The European field experience data may be of great importance to manufacturers as well as to regulatory authorities elsewhere in the world. Such data may allow early identification of a difference between expected and actual product performance and allow prompt corrective and preventive actions. This has the potential for improving patient safety worldwide.

In the recent past, communication about CRM device performance among stakeholders has been less than optimal. Indeed, it is unfortunate that many patients with such devices first learned about reported problems from articles in the lay press or from the internet much earlier than from their physician. This has caused widespread misunderstanding about potential device failures and, more importantly, suspicion and lack of confidence between physicians and patients, between professionals and industry, and between regulators and industry.

During the policy conference convened by EHRA, several current issues and potential areas of improvement were identified (*Table 1*). Taken together, these observations

\* Corresponding author. Tel: +41 91 805 3340; fax: +41 91 805 3787.  
E-mail address: angelo.auricchio@cardiocentro.org

**Table 1** Key topics discussed at EHRA policy conference in Nice on January 2006

Identification of obstacles for the assessment of the denominator and numerator (or patients at risk/patients presenting with device failure) in Europe
Failure modes and effects
Hazard analysis
Review process
Reporting process
Information flow

and ideas outline a framework for future action on the regulatory and the public policy fronts and a basis for formulating clinical guidelines for the future with the aim of better patient management. This document represents a joint effort of clinical professionals, regulatory body representatives, and industry members. This is intended to offer general guidance to physicians, regulatory authorities, and the CRM device industry in the shared interest of safer patient management. (This document is intended to summarize the observations and recommendations developed at the EHRA policy conference: it represents a consensus reached by the drafting committee members even if not necessarily each statement represents the views of individual members of the drafting committee members and/or their employers.)

## Definitions and nomenclature

The term recall has no univocal meaning. In USA, the Food and Drug Administration (FDA) uses the term 'recall' to encompass many different actions, including physical recalls, but also includes other forms of communications issued by manufacturers.<sup>7</sup> Furthermore, FDA classifies 'recalls' into three classes on the basis of the potential for the underlying problem to cause death or injury, a system not used in Europe. Thus, recall carries with it many different connotations and the potential for confusion. In Europe, it is used mostly in the sense that a device is physically removed from service and returned to the manufacturer; this is not the case in most CRM device actions. The terms preferred in Europe, and which will be used hereafter in this paper, are 'advisory notice' or 'FSCA'.<sup>8,9</sup>

An advisory notice or FSCA may be issued after an incident or near-incident has occurred and where preliminary investigation has found that systematic widespread action is appropriate.<sup>9</sup> Where known, such incidents and near-incident must be reported by the manufacturer to the National Competent Authority. A serious adverse incident is defined as an event, associated with the use of a device, resulting in actual or potential death or serious deterioration in the health of a patient or other person such as those resulting in permanent impairment of body structure or function (injury) or requiring additional surgical/medical intervention to prevent impairment.<sup>9</sup>

In general, FSCA advisory notices are issued by the manufacturer directly to medical device purchasers and/or users, usually following consultation with the National Competent Authorities. Individual regulatory authorities monitor manufacturer's investigation and actions and may also issue their

own advisory notices to National Health Services or others and make them publicly available.<sup>8,9</sup>

Manufacturers typically take corrective and preventive action at many levels, in design, testing, new production, instructions for use, and/or FSCA, as appropriate to the circumstances.

## Importance of reporting device failures

As with any mechanical or electronic apparatus, CRM devices may fail through a variety of potential, predicted and unpredicted,<sup>10,11</sup> malfunctions. Unprecedented advances in technology have enabled industry to market CRM devices with near 99% reliability over the device lifetime.<sup>12</sup> However, the reliability, performance, safety, and effectiveness of a specific device may be significantly lower in the post-market phase as additional factors such as operator skill, patient selection, and follow-up may play a role, and long-term adverse events come to light.<sup>13</sup>

In general, evaluation of device performance depends upon a high degree of knowledge of actual device failure occurrences and failure modes (the 'numerator') over the population of devices that remain in service (the 'denominator'). It must also take into account the severity of any clinical consequences associated with those failures. The frequency and clinical effects of device failure are by far the most relevant parameters in deciding on actions that need to be taken as a result of device problems. Yet, knowing the actual frequency of device failure is highly dependent on timely and accurate reporting by physicians. This may represent the weakest link in the chain of events, which ultimately may lead to a recall or other corrective action (FSCA).<sup>14</sup>

Although no published data are available, anecdotal evidence indicates that active notification of incidents or near-incident by clinicians to manufacturers and/or regulators (a system known as 'medical device vigilance') is significantly underdeveloped in Europe as well as in the rest of the world. Thus, the physician community has a profound and important responsibility in this area.<sup>15</sup> However, it is recognized that notification of device-related incidents/near-incident by physicians should be made as simple as possible. Indeed, in some European countries, this process requires notification to both the manufacturer and the regulatory authorities, sometimes separately. Despite significant progress by the European Commission and Member State Competent Authorities in harmonizing the medical device legal framework in the EU, significant national differences still exist. Thus, full implementation of the European directives in this regard at national level can be considered near-optimal in only a few countries. Although active reporting by physicians of incidents and near-incident involving CRM products is mandatory in some European countries and regulated at national level by the relevant Competent Authority, this seldom occurs. The EU directives do not cover adverse incident reporting by physicians—only manufacturers. In large part, this is because regulation of health care practice is a matter for the Member States and beyond the competence of the European institutions. Therefore, there is a real need to promote the importance of such reporting by physicians to the manufacturer and/or Competent Authority.

Notification from physician to industry and/or Competent Authority may be a time-consuming process. Many physicians have expressed difficulties in knowing what to report, when to report, to whom to report, and how to report. Yet, the fact remains that the physician and patient communities directly benefit from continuous improvement in medical device performance driven by such event notification. Experience in the UK at MHRA (Medicine and Healthcare products Regulatory Agency) is particularly helpful in this regard. Indeed, it shows that, when active notification is encouraged by using a simple voluntary reporting process (Figure 1), the frequency of clinician notification is significant. This enables regulatory authorities and industry to take and promote clinical action based on actual data. In particular,

it gives more information about the true incidence of an adverse event.

EHRA recommends that measures be taken to encourage National Competent Authorities to work with clinician/scientific societies to improve event reporting at national level. Specifically, the proposal of a single, standardized multi-lingual incident notification sheet (possibly similar to that adopted by the UK MHRA) in Europe may favour the creation of a standardized process of reporting incidents or near-incidents. This would help regulatory authorities as well as manufacturers in improving CRM product performance, issuing more helpful and focused advice to clinicians, and ultimately leading to improved patient safety. In addition, device-specific incident reporting evidence might be helpful.

**Medical Devices Agency Implantable Pacemaker / Defibrillator MALFUNCTION REPORT FORM**  
ENTER DATA WHERE READILY AVAILABLE - DO NOT DELAY RETURNING FORM

**1 PLEASE ENTER BELOW YOUR NAME, DEPARTMENT AND HOSPITAL / CLINIC ADDRESS**

NAME.....	HOSPITAL.....
DEPARTMENT.....	ADDRESS.....
TELEPHONE..... EXTN.....	.....
FAX.....	.....
DATE..... Email.....	PICODE.....

**2 PLEASE ENTER DETAILS OF TOTAL SYSTEM IMPLANTED (PG, ICF, PCD, LEADS etc) Clinical Trial Device**

[Circle to identify item(s)]	MANUFACTURER	MODEL NAME	MODEL NUMBER	SERIAL NUMBER	PROGRAMMED AS
DEVICE: [PG] [CD] [ATR / VENT] [OTHER: ]					[BIPOLAR] [PolyU] [UNIPOLAR] [Silicone]
LEAD 1: [ATR] [VENT] [DEFIB] [OTHER: ]					[BIPOLAR] [PolyU] [UNIPOLAR] [Silicone]
LEAD 2: [ATR] [VENT] [DEFIB] [OTHER: ]					[BIPOLAR] [PolyU] [UNIPOLAR] [Silicone]
LEAD 3: [CS] [SVC] [OTHER: ]					[BIPOLAR] [PolyU] [UNIPOLAR] [Silicone]

**3 PLEASE IDENTIFY   THE FAILED / SUSPECTED COMPONENT(S) PROVIDING RELEVANT INFORMATION**

DEVICE [ ] LEAD 1 [ ]	IMPLANTING CENTRE: (if not address above)
LEAD 2 [ ] LEAD 3 / OTHER [ ]	
DATE OF IMPLANTATION: / /	FAILED DATE: / /
	EXPLANTED: [Y] [N] DATE: / /
MODE OF FAILURE OR REASON FOR EXPLANT / TERMINATION <input checked="" type="checkbox"/> Premature End of Life: [ ] Power On Reset: [ ] Back-up Mode Pacing: [ ]	
CLINICAL SYMPTOMS/OBSERVATIONS: Attached <input checked="" type="checkbox"/> Programmer Printout: [ ] ECG Strip: [ ] Holter Analysis: [ ]	
Patient Death: [ ] Reported to Coroner: [Y] [N] [Unknown] Date of last follow-up: / / Date of 2 <sup>nd</sup> last follow-up: / /	

**4 PERFORMANCE INFORMATION (WHERE KNOWN)**

<input checked="" type="checkbox"/> LOSS OF TELEMETRY: FULL [ ] PARTIAL [ ]	<input checked="" type="checkbox"/> LOSS OF CAPTURE: [ ] UNDER SENSING: [ ] OVER SENSING: [ ]
BATTERY DATA: Telemetered STATUS INDICATOR	GAS GAUGE INDICATOR
MEASURED MAGNET RATE: bpm	MEASURED PACING RATE: bpm
EXPECTED MAGNET RATE: bpm	PROGRAMMED PACING RATE: bpm
MEASURED LEAD IMPEDANCE: [ ] ohms [BIPOLAR] [ ] ohms [UNIPOLAR]	LEAD 2: [ ] ohms [BIPOLAR] [ ] ohms [UNIPOLAR]
	LEAD 3 / OTHER: [ ] ohms [BIPOLAR] [ ] ohms [UNIPOLAR]

**5 COMMUNICATIONS WITH MANUFACTURER**

LOCATION OF FAILED ITEM(S)	MANUFACTURER INFORMED <input checked="" type="checkbox"/> <input type="checkbox"/> Who?
NATURE OF ADVICE PROVIDED BY MANUFACTURER	WRITTEN [Y] [N] VERBAL [Y] [N] Product Already on Advisory [Y / N] Who?

RETURN TO -> AIC Mail Point 9/N - Medical Devices Agency - Hannibal House - LONDON SE1 6TQ OR FAX TO -> 0207 972 8109/8106

Figure 1 Implantable pacemaker/defibrillator malfunction report form by UK MHRA. The form is well structured allowing comprehensive performance information.

Explantation of CRM devices from patients who die of suspected cardiac or non-cardiac causes is at present not regulated. Moreover, protection of patient privacy may, in some situations, represent a major obstacle to defining better the circumstances related to device failure or investigating whether a cause-effect relationship between a device and an incident can be established. As many of the CRM device manufacturers are based outside the EU, transmission of personally identifiable data is severely restricted. This makes it difficult for manufacturers to maintain accurate and timely records of device implantation and current status. Moreover, timely reports of incidents and near-incidents along with return of explanted devices are of great value.<sup>16</sup> Indeed, manufacturers are, therefore, often faced with a large number of returned devices in one package. If no details of patient or device are supplied, no action can be taken.

Even if one is able to achieve complete, timely, and active reporting of cause, mode, and effect of device failure in a particular incident, full knowledge of the number of similar devices actively in service at a given point in time (the denominator) is a fundamental prerequisite for accurately assessing the failure rate. Such denominator information is poorly known in Europe as industry and Competent Authorities typically lack information on the number of devices that remain in active service.

EHRA shares the view that efforts to improve the recording and reporting processes for implanted and explanted devices are highly desirable and should be supported by the European physician community. For better patient management, from this point of view, an internet-based registry and automatic device monitoring system may be a future, but affordable, way of actively tracking device function and devices that remain in service. The authors recognize that establishment of such systems would require broader adoption of existing technologies, training of physicians and associated health professionals, infrastructure, and payment mechanisms.

The information about denominators and numerators should be collected in a systematic registry. However, precise definition of the 'ideal' registry system is of great importance, e.g. what information would be gathered and held, how would it be organized, who would be responsible for entering and editing such data, who would have access to such a database, the purpose for which the data would be used, at the European vs. National level, independent vs. manufacturers, protection of personal private data, etc. Whether an independent European registry should exist or the establishment of links among international registries should be favoured is an open point of discussion. Finally, costs related to pursuing actively device surveillance on a large-scale are unknown, nor is it yet established whether dedicated funding from industry and regulatory/vigilance bodies should be assigned. These and many other aspects need to be elucidated.

*The role of EHRA in contributing to better knowledge of numerators and denominators can be summarized in the following points (Figure 2):*

- *promote better adverse incident reporting by professionals to manufacturers and National Competent Authorities;*

- *develop a uniform EU incident reporting format for CRM device-related incidents;*
- *improve education of members on regulatory requirements.*

In making decisions as to future patient management particularly the need for explantation after adverse events needs to take into account other information. The role of EHRA in helping to accumulate this information can be summarized in the following points:

- *encourage collection of data on morbidity/mortality associated with explantation of CRM devices as a baseline for comparison of risks;*
- *ensure adequate data collection from cohort post-market clinical studies, also as a baseline for comparison of risks;*
- *encourage all explanted devices to be sent in a timely manner to manufacturers for routine and/or in-depth analysis, as appropriate with clinical and technical details.*

## Manufacturer risk management processes

There is a great deal of information available in the CRM product industry from which to provide physicians and patients with the best device safety and performance information. Despite significant efforts and very expensive quality control processes, perfection cannot be achieved and is unlikely ever to be achieved. As part of their established quality management systems, manufacturers have extensive ongoing risk management processes. These processes are established according to the harmonized international standards and are subject to periodic audits by European Notified Bodies. Manufacturers have established systems for the collection, analysis, and evaluation of product experience reports, including, but not limited to, complaint handling processes, vigilance reporting, failure analysis, and trend analysis. Moreover, manufacturers are bound to have in place a mandatory post-market surveillance system in order to gather information relating to ongoing product performance and identification of unanticipated adverse events. Manufacturers have access to engineering, scientific, and clinical advice from internal resources and outside advisors. As part of their risk management processes, manufacturers typically establish procedures for assessing emerging product-related risks and determining appropriate corrective and preventive actions, including communications to regulatory authorities and the clinical community.

However, at the EHRA policy conference, Competent Authority representatives and professionals felt that early engagement in manufacturer risk management process is highly desirable.

*It was suggested, and supported by the writing group, that a forum for informal discussion of product performance issues in complete confidence be established (Figure 2). Rules for setting up and operating such a committee would need to be defined, and the legal framework and the degree to which manufacturers and others might be bound by such recommendations would have to be established.*

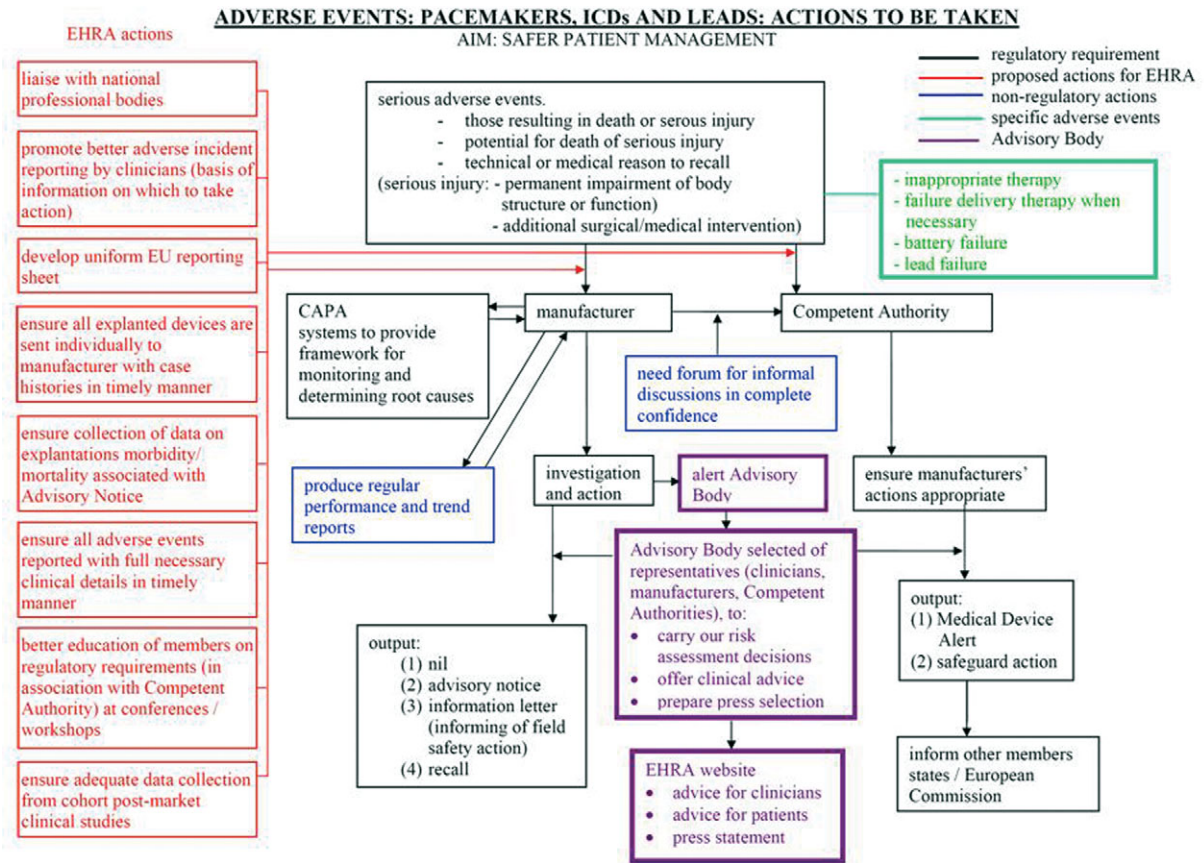


Figure 2 Adverse events of CRM products and actions to be taken by stakeholders aiming at safer patient management.

**Hazard analysis**

To determine whether a recall or other FSCA is required once a potential hazard has been identified, the manufacturer should perform a structured hazard analysis in the framework of competing risks. This process is an ongoing element of the manufacturer’s quality management system and it springs from their obligation in law to ensure that medical devices placed on the market are safe. In addition, the Competent Authority will typically also perform a risk assessment based on information provided by the manufacturer and from other sources including clinical opinion and adverse incident data.

**Hazard risk evaluation at population level**

The importance of the risk exposure over time to a device, lead, or system failure needs to be emphasized. For example, an ICD failure does not mean that the patient dies (except in the very rare case that an ICD patient is completely pacing-dependent), it means that the patient is unprotected against life-threatening tachyarrhythmias should they occur. The resulting risk depends on the time interval from failure to the remedial action taken upon detection of the problem. It should be considered that some failures might happen immediately after a follow-up check, others just before the next check. On average, the time of exposure to the risk of not having a functional ICD will be half of the follow-up interval. It is obvious that frequent follow-up visits significantly reduce the exposure

risk of a patient, yet they significantly affect the patient’s and family’s quality of life. They also create a serious, and mostly unnecessary, overload of hospital and outpatient facilities. All of the above assume, of course, that potential failures can, in fact, be detected at routine follow-up checks, but this may not always be the case. New internet-based device monitoring may provide near daily information on system performance. If widely adopted, the increased frequency of system check-ups (e.g. daily interrogation) will reduce the window of risk exposure to just a few hours with a consequent huge increase in device reliability, defined as probability of success of the therapy and overall care system over time and, finally, in patient safety. However, it is still unclear which parameters should be continuously monitored and available ‘on-line’ via the internet in order to improve patient safety. All these external systems, however, will not change the inherent reliability of the implanted device.

Apart from the intrinsic risks related to device failure, the expected risks associated with device replacement should be fully taken into consideration when making clinical management decisions. At present, there is ignorance about the frequency and severity of complications related to device explantation and replacement. Professionals and Competent Authority representatives at the EHRA policy conference were very clear in calling for more longitudinal data on complications associated with device explantation and replacements. Indeed, these findings are eagerly awaited as a basis for physician, regulator, and manufacturer risk assessment.

The prospective collection of such data, in a study endorsed by EHRA, should be initiated and the results made publicly available (Figure 2).

**Hazard risk evaluation at individual level**

Although CRM manufacturers and regulatory agencies are mostly interested in assessing (and can generally only assess) risk at population level, physicians must evaluate and act on risk at the level of the individual patient, taking into account his/her condition.<sup>17</sup> Thus, the probability and severity of device failure should be weighted by other considerations (Figure 3). Moreover, advice relating to risk of removing one device and replacing it with a new one cannot be made in a general fashion, but will need to take into account a number of factors including the patient’s medical condition and wishes. In order for such a decision to

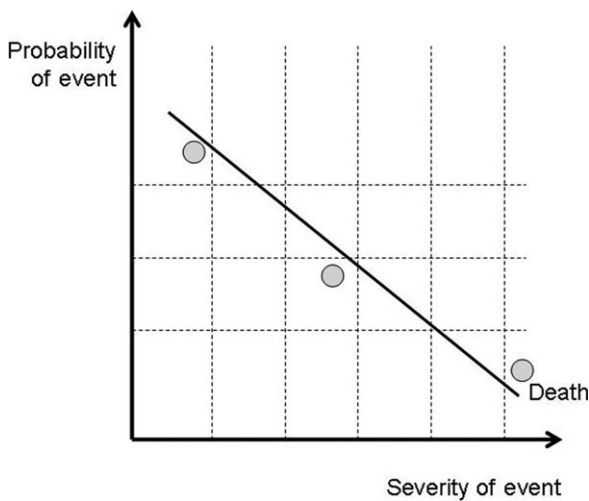


Figure 3 Severity and probability of device failure.

be taken, a hazard matrix containing different risks potentially present at different times and under different conditions should be generated. The writing committee considered whether special numeric thresholds for useful clinical recommendations could be developed. It was concluded that, at this stage, no simple recommendations were appropriate without further research and discussion.

This hazard matrix may include (i) a hazard intrinsic to a device, lead, or implanted system (estimated manufacturer’s failure rate over product lifetime), (ii) a hazard related to a replacement procedure of a device, lead, or both, (iii) a hazard related to a specific patient’s condition, and (iv) a hazard related to the current indication for the device implantation, i.e. primary or secondary prevention of sudden cardiac death (Figure 4).

The concept of current indication for device implantation is significantly new and more relevant than one reporting the original indication for device implantation. Indeed, as the clinical condition of the patient may evolve, the most recent arrhythmic (both brady- and tachyarrhythmias) status is relevant in the event of FSCA.

It is suggested that it may be important to note current patient arrhythmic profile in the patient’s device card or record, continuously update it at each follow-up visit, and to track this in the in/outpatient clinic file for fast assessment in the case of an FSCA. This will greatly help in prioritizing unscheduled follow-up visits of patients in the case of a recall or FSCA.

**European medical device regulation process**

In Europe, the manufacture and bringing to market of CRM management products are under the scrutiny of private third-party conformity assessment bodies known as ‘Notified Bodies’. These Notified Bodies are appointed and overseen by National Competent Authorities (National Regulatory Body, e.g. Ministry of Health) of each EU Member State.

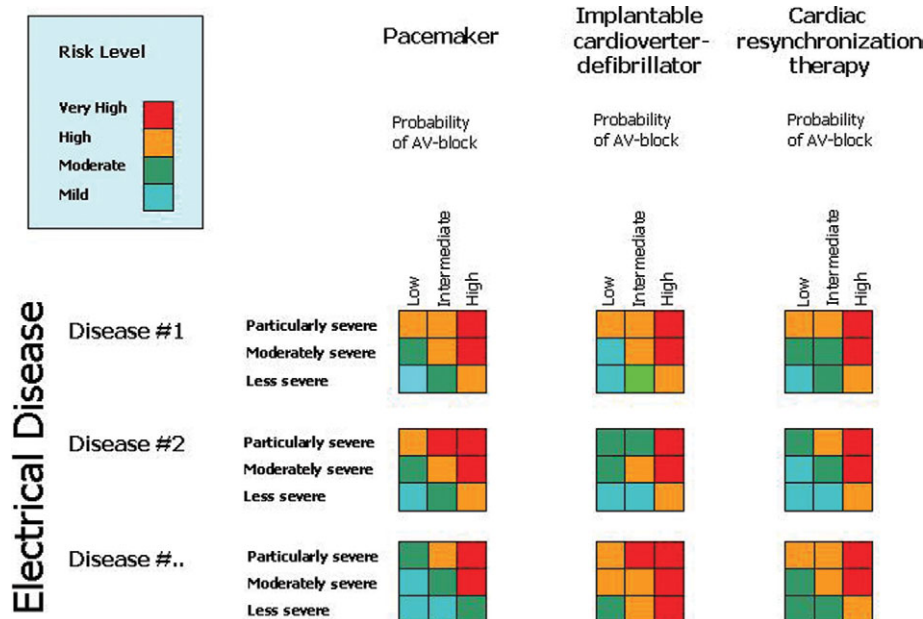


Figure 4 Individual risk prediction charts in the case of CRM product management failure. Risk prediction matrix is based upon several parameters including type of device implanted, pacemaker dependency, actual rhythm status, and arrhythmia status.

Each Member State has transposed the requirements of the European directive on active implantable medical devices (90/385/EEC) into National Law.<sup>8</sup> Those requirements govern the manufacturer's quality management system, essential requirements of device safety and performance, conformity assessment procedures, and post-marketing surveillance activities, including vigilance requirements. They also govern the responsibilities of Notified Bodies and Competent Authorities, including pre-market conformity assessment and market control activities. In each European country, National Regulatory and Vigilance Agencies are in place in order to regulate and monitor the safety of any medical device or, more pertinent to our discussion, active implantable medical devices.<sup>8</sup>

The European Medical Device Directives require manufacturers to implement a process to review the experience gained in the post-production phase and to implement appropriate means to apply any necessary corrective action.<sup>9</sup> Notification by the manufacturer to the relevant National Competent Authority of the cause of serious incidents or near-incidents within a certain number of days is mandatory. A guidance document for manufacturers and Competent Authorities has been prepared by the Commission-sponsored Medical Device Expert Group. A central European database has also been established but is not yet fully operational. It is expected to contain information on final vigilance reports and investigations completed by Competent Authorities. It will be accessible to the Member States. Therefore, the European medical device vigilance process delegates to the industry the primary responsibility for monitoring of device failures, the reporting process, and corrective actions, under the supervision of Competent Authorities and Notified Bodies.<sup>9</sup> Some weaknesses of this system have been recognized by the Member States and European Commission, and measures to improve implementation have been developed.

### Advisory body to CRM manufacturers, regulatory authorities, and physicians

The guiding principles for starting an FSCA process should be (i) patients and physicians considerations come first, (ii) actions and decisions must be based on sound engineering and medical principles, and (iii) actions should be taken when such actions benefit patients or physicians. Obviously, actions must comply with applicable laws and regulations. If the risk of mechanical, electrical, or software failure is significantly larger than the calculated risk of explantation and new implantation, the potential consequences of a device failure are severe, and the mode of failure cannot be reliably detected, then an FSCA should be launched. So far, Competent Authorities and physicians have generally relied on industry decisions to start this process.

*During the EHRA policy conference on CRM Medical Device Performance, the creation of a permanent 'advisory panel', under the auspices of EHRA was proposed (Figure 4). It was envisioned that this body would offer expert advice to physicians, regulatory authorities, and manufacturers on the clinical aspects of managing patients with implanted CRM devices involved in FSCA and/or recalls. This body might also assist in risk assessment and preparing standby statements for media inquires.*

Taking into account the view expressed in the policy conference and from subsequent discussion, in establishing such an advisory body, EHRA/ESC should consider the points indicated in *Table 2*.

### Product performance reports

Reports of CRM product performance are typically published annually by manufacturers. This is the most comprehensive overview of CRM product performance for a selected manufacturer. Notably, the amount and detail of product performance published by manufacturers of implantable CRM devices are greater than that for any other medical device. In the present format, product performance reports are helpful for recognizing CRM product trends, but should not necessarily be used by a physician for taking a decision about the treatment of a specific patient.

The US Food and Drug Administration Manufacturer and User Facility Device Experience (MAUDE) database is a large collection of individual reports of adverse events, supplied to the FDA by medical device manufacturers and device user facilities.<sup>1</sup> Although the manufacturer's published periodic performance reports may include information derived from those individual event reports, they are not the same, either in content or in purpose.<sup>13</sup>

Among other tools, industry uses 'cumulative survival' analysis to characterize product reliability and longevity. Such curves typically describe the probability of product survival at each stage of service life. For example, in the case of a pulse generator, a cumulative survival of 99% at 5 years indicates that at 5 years post-implant the device has a 1% probability of incurring a malfunction or normal battery depletion. This analysis can be applied to each part of the implantable system, including the pulse generator, lead, and connectors, if any, or to the entire system as a whole. The analysis of actual, rather than predicted, performance is, however, significantly biased by the higher probability that a suspected defective pulse generator will be returned to the manufacturer than a failed lead or connector.

Today, all manufacturer product performance reports include exclusively or predominantly failure data from the

**Table 2** Flowchart for the development of a permanent advisory body

Mandate and scope of advisory body activities
Qualification of advisory board members
Impartiality of advisory board members and process
Role of National Competent Authorities in advisory board process
Role of industry in advisory board process
Threshold for inviting advisory board review
Timelines of review and advice
Confidentiality
Methods of working
Expected products and methods of communication
How physicians might use advisory board advice in their clinical practice
How National Competent Authorities might use advisory board advice
How manufacturers might use advisory board advice
Potential liability of EHRA, ESC, and/or advisory board members arising from the process and advice issued
The form and intended use of any media statements

United States device populations. It might be assumed that product performance should be the same in Europe as in the USA, thus making collection of the European data less useful. However, as mentioned in the introduction, active European data collection should be actively pursued in order to allow early detection of issues or product performance drift, especially for devices that are not yet, or only recently, marketed in the USA or other markets.

Although there are many similarities in the product performance reports by different manufacturers, significant differences are also appreciated. This indicates that manufacturers do not currently use identical definitions and measurements. Nearly all manufacturers report pulse generator cumulative survival rates, based on battery depletions and failures confirmed by returned product analysis, and all companies adjust for unreported patient mortality. In contrast, some manufacturers list the number of failures for each device family, whereas others do not, and some manufacturers distinguish between electrical, mechanical, and software failures, others do not. Notably, some product performance reports break out device populations subject to advisory notices. Using this method, the subset of devices subject to advisories does not detract from overall family performance, but the separate subpopulations do allow a physician to understand the performance of a specific patient's device. Finally, differences are appreciated when reporting the causes of failures (electrical, mechanical, software) and whether the reported premature battery depletion was confirmed or not confirmed by manufacturer analysis. Altogether, from manufacturer's published product performance reports, it appears that the number of differences is larger than the number of similarities, so that comparisons, and comparative claims, between manufacturers are not possible.

*Therefore, it is concluded that a standardized reporting process is mandatory in the interest of patient safety and should be pursued by manufacturers, regulatory authorities, and physicians. Transparency and consistency across the industry will help all parties make more informed decisions. Such efforts by industry are already under way.*

## Communication process

The manufacturer's decision to submit a vigilance report to the Competent Authority(ies) is usually made when an incident or near-incident (fulfilling defined criteria) has occurred, when predicted device performance does not achieve design or performance expectations, or when the manufacturer identifies an opportunity to recommend to the clinical community a strategy for improved patient outcomes related to device function.

*The communication steps leading to more transparent and timely information among the stakeholders should be better clarified, and some rules need to be defined as discussed in the following sections. Furthermore, EHRA envisions a possible role for itself in explaining scientific and medical issues associated with such advisory communications to the media and other interested persons.*

### Step 1: communication between industry/Competent Authority and physician

When an advisory notice on a specific CRM product is made, timeliness, content clarity, utility, and value of such

communications are extremely important. Moreover, as no standardized format exists in which to communicate an FSCA from the manufacturer to physicians, manufacturers use different formats when presenting the issue and proposing a solution. However, a more homogenous way of information delivery would be highly appreciated by the physician community, especially by non-specialist physicians. In this view, the medical device alert format used by the UK MHRA is particularly interesting. In a concise manner, it summarizes on the front page the most relevant information, such as alert reference number, target device, problem, action required, and by whom, etc. (Figure 5). This format is particularly appreciated by UK cardiologists and non-specialist physicians, as well as hospital management.

### Step 2: communication between physician and patient

The number of patients treated with active implantable medical devices has considerably increased over the last decade and it is expected to increase further exponentially over the coming years around the world. This creates the need to provide reliable information and reasonable advice in a short time to those patients implanted with a possibly failing device or component. The growth in adoption of such therapy has also driven increasing media interest in stories involving such technology and patients.


If rapid dissemination of product performance information was the only consideration, an announcement through the mass media might be the most effective way. The serious drawback of this strategy, however, is that patients or family members may be suddenly faced with an issue that they cannot directly understand or handle. This may cause panic and frustration if timely and appropriate information from their cardiologist cannot be obtained. Thus, a press embargo strategy might be proposed when a manufacturer and a regulatory authority issues an FSCA. This embargo would guarantee that physicians and hospital administrations receive all necessary information well ahead of the time that any media coverage starts, thus allowing them to prepare necessary measures. However, there is no assurance that such an embargo would be effective and this strategy may well conflict with constraints imposed on manufacturers by security law.

An FSCA exposes physicians, nurses, and hospital infrastructures to a sudden increase in workload, which in some situations can be difficult to handle.<sup>18,19</sup> For large-scale actions, a strategic plan at national level and at large regional hospitals may need to be set up in order to handle optimally patient calls seeking medical advice. It is desirable to have telephone and internet-based hot lines which may be accessed by the patient or their trusted physician. Thus, financial and human resources for covering such unpredictable events should be allocated and negotiated among the parties. During some recent FSCAs, some manufacturers have provided internet-based 'look up tools' on their websites to allow physicians and patients to determine whether a particular device is subject to the action.

### Step 3: communication between EHRA and media

In the FSCA recent past, it is unfortunate that many patients first learned about device issues in the lay press or internet





**MHRA**  
Medicines and Healthcare products  
Regulatory Agency

## Medical Device ALERT

**Ref. MDA/2005/037**  
Issued: 27 June 2005

<b>For:</b>	IMMEDIATE ACTION		
	<b>ACTION</b>	<input checked="" type="checkbox"/>	
	UPDATE	<input type="checkbox"/>	
	INFORMATION REQUEST	<input type="checkbox"/>	

	Further Information						
<b>DEVICE:</b> Guidant VENTAK PRIZM <sup>®</sup> 2 DR implantable cardioverter defibrillator (ICD) model No 1861 - see Appendix for full list of affected serial numbers.							
<b>PROBLEM:</b> Potential loss of cardioversion, defibrillation or pacing therapy due to diversion of high voltage shock.	▶						
<b>ACTION BY:</b> All cardiologists and cardiac technicians who manage patients implanted with a VENTAK PRIZM <sup>®</sup> 2 DR ICD.							
<b>ACTION:</b> See action points on page 3.	▶						
<b>DISTRIBUTED to:</b> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">NHS Trusts (England)</td> <td style="width: 50%;">- Chief Executives*</td> </tr> <tr> <td>Healthcare Commission (CHAI)</td> <td>- Headquarters</td> </tr> <tr> <td>Primary Care Trusts (England)</td> <td>- Chief Executives*</td> </tr> </table> <small>* via CE Bulletin</small>	NHS Trusts (England)	- Chief Executives*	Healthcare Commission (CHAI)	- Headquarters	Primary Care Trusts (England)	- Chief Executives*	▶
NHS Trusts (England)	- Chief Executives*						
Healthcare Commission (CHAI)	- Headquarters						
Primary Care Trusts (England)	- Chief Executives*						
<b>CONTACTS:</b> Details of manufacturer contacts, National Pacing and ICD Database and MHRA contacts for technical and clinical aspects. Change of address or removal from address list for Healthcare Commission.	▶						

▶ Further information supplied in the following pages.

The full text of this notice is on our website: <http://www.mhra.gov.uk>

Page 1 of 6 pages

Figure 5 UK MHRA—medical device alert form.

much earlier than, or at the same time as, their cardiologist. This has caused widespread misunderstanding surrounding the issues of device failure, but more importantly, suspicion and diffidence between physicians and patients and between professionals and industry. In several instances such a situation has developed because US FDA requires certain timing on communications (before EU Competent Authorities can be informed) and because European and US security regulations require public information to all parties at the same time. To further complicate the issue the media may become unofficially aware of an impending action, which results in a further acceleration of the timeline for notification. It is a difficult challenge to balance the often conflicting needs or desires for information of all interested parties. This direct dialogue, industry/media, has been heavily, on many occasions, criticized by professionals, patients, Competent Authorities, and by the industry itself.

*EHRA proposes to take an active role as the voice of physicians in the case of a proposed FSCA. EHRA can help to*

*interpret, present the clinical situation, and interact with the media based on information generated by the industry and/or regulatory authorities in the event of an FSCA involving CRM devices.*

### Conclusions

It is quite clear that CRM product performance is no longer an issue limited to one manufacturer or to a specific product. Because of that fact, and because product failures are unpredictable, yet rare, strategic actions should be prepared in order to enhance patient safety, unbiased information flow among key stakeholders, and continuous product improvement. The EHRA, as a recognized scientific society, is committed to provide its expertise and unlimited support to the European and other international regulatory authorities in order to improve the patient’s quality of life and survival as well as to set up and to manage the framework of a productive dialogue between manufacturers and professionals. Therefore, this document aims to outline

specific tasks, to propose potential resolutions of a significantly complex problem, and to stimulate and inform a robust policy debate. It is the first step of a long, continuous process, which we hope will improve patient management. As a follow-up of this document, further initiatives will take place specifically focusing on the different issues related to CRM product management. In particular, the concepts in italic type in this document may represent concrete starting points which need to be developed singularly by *ad hoc* subcommittees where each of them will include representatives from manufacturers, Competent Authorities, and cardiologists.

## Acknowledgements

The authors gratefully acknowledge the support of the European Society of Cardiology, the European Heart Rhythm Association, and the European Heart House for the organization of the EHRA policy conference on assessment of device performance in electrophysiology, held at the Heart House in Sophia Antipolis, 12–13 January 2006.

## References

1. Hauser RG, Kallinen L. Deaths associated with implantable cardioverter defibrillator failure and deactivation reported in the United States Food and Drug Administration Manufacturer and User Facility Device Experience Database. *Heart Rhythm* 2004;1:399–405.
2. Hauser RG, Maron BJ. Lessons from the failure and recall of an implantable cardioverter-defibrillator. *Circulation* 2005;112:2040–42.
3. Becker C. Stuck with the check? Guidant recall raises questions of medical tab. *Mod Healthc* 2005;35:20–22.
4. Senges-Becker JC, Klostermann M, Becker R *et al.* What is the “optimal” follow-up schedule for ICD patients? *Europace* 2005;7:319–26.
5. Goldman BS, Newman D, Fraser J, Irwin M. Management of intracardiac device recalls: a consensus conference. Participants of the Consensus Conference. North American Society of Cardiac Pacing and Electrophysiology (NASPE). *Pacing Clin Electrophysiol* 1996;19:7–17.
6. What to do in the wake of an implantable defibrillator recall. *Heart Advis* 2005;8:2.
7. Maisel WH, Sweeney MO, Stevenson WG, Ellison KE, Epstein LM. Recalls and safety alerts involving pacemakers and implantable cardioverter-defibrillator generators. *JAMA* 2001;286:793–99.
8. Council Directive 90/385/EEC of 20 June 1990. In [http://europa.eu.int/comm/enterprise/medical\\_devices/legislation\\_en.htm](http://europa.eu.int/comm/enterprise/medical_devices/legislation_en.htm)
9. Guidelines on a Medical Devices Vigilance System, [http://europa.eu.int/comm/enterprise/medical\\_devices/meddev/2\\_12-1\\_\\_\\_04-2001.pdf](http://europa.eu.int/comm/enterprise/medical_devices/meddev/2_12-1___04-2001.pdf)
10. Kawanishi DT, Song S, Furman S *et al.* Failure rates of leads, pulse generators, and programmers have not diminished over the last 20 years: formal monitoring of performance is still needed. BILITCH Registry and STI-MAREC. *Pacing Clin Electrophysiol* 1996;19:1819–23.
11. Furman S. Recall by Telectronics Pacing Systems of all unimplanted Accufix atrial “J” pacemaker leads, models 330-801. *Pacing Clin Electrophysiol* 1995;18:375.
12. Ellinor PT, Guy ML, Ruskin JN, McGovern BA. Variability in implantable cardioverter defibrillator pulse generator longevity between manufacturers. *Pacing Clin Electrophysiol* 2003;26:71–75.
13. Tyers GF. FDA recalls: how do pacemaker manufacturers compare? *Ann Thorac Surg* 1989;48:390–96.
14. Goldman BS, Newman D, Fraser J, Irwin M. Management of intracardiac device recalls: a consensus conference. *Can J Cardiol* 1996;12:37–45.
15. MacGregor DC, Noble EJ, Morrow JD, Scully HE, Covey HD, Goldman BS. Management of a pacemaker recall. *J Thorac Cardiovasc Surg* 1977;74:657–67.
16. Kaczmarek RG, Beaulieu MD, Kessler LG. Medical device tracking: results of a case study of the implantable cardioverter defibrillator. *Am J Cardiol* 2000;85:588–92.
17. Nanthakumar K, Dorian P, Ham M *et al.* When pacemakers fail: an analysis of clinical presentation and risk in 120 patients with failed devices. *Pacing Clin Electrophysiol* 1998;21:87–93.
18. Sneed NV, Finch NJ, Leman RB. The impact of device recall on patients and family members of patients with automatic implantable cardioverter defibrillators. *Heart Lung* 1994;23:317–22.
19. Llewellyn MJ, Bennett DH, Shearer KS, Slaven YM. The impact of a manufacturer’s revision of pacemaker service life on the workload of a large pacing center. *Pacing Clin Electrophysiol* 1989;12:1014–17.