BARRIERS TO REDUCING USELESS EXAMS IN IONIZING MEDICAL IMAGING: AN OVERVIEW

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Abstract

 Appropriateness in imaging studies is recognized as an important feature in National Health Services, especially in those nations where per capita health spending has been substantially increased. This is important in view of the projected spectacular rise of ionizing imaging tests in next years; yet their explosive growth in performance is challenging to be interpreted as it may represent an added value when appropriate, and an added cost when inappropriate or overused (Picano, 2009).

 In order to define this, over the past thirty years researchers have conducted several studies to examine the relationship between risks and perceived usefulness, attitudes, and the usage of ionizing examinations, embracing the risk-benefit relation as a suggested policy for improving health services.

 However, until relatively recently, little had been done on these issues, and even now, both patients and physicians generally ignore the potential harmful effects of the inappropriate use of diagnostic medical procedures. So, the aim of this review is to discover, basing on the literature, why inappropriateness is still so high and to show that many of the difficulties faced by National Health Services in the reduction of inappropriateness are caused by a lack of awareness of, and training in, communication strategies.
Barriers to reducing useless exams in ionizing medical imaging: an overview

In the past hundred years, diagnostic radiology, nuclear medicine and radiation therapy have evolved from the original crude practices to advanced techniques that form an essential toolkit for all branches and specialties of medicine, both in diagnosis and therapy.

At present, although many patients derive great benefit from these procedures, some suffer radiation-induced injuries as an unintended consequence. In fact, even though technologic progress has improved image quality while reducing exposure rates, the greater exposure duration that attends more complex procedures may lead to an increased overall patient and operator exposure accompanied by a greater potential for radiation-induced injury (Picano, 2005). The same is for therapeutic techniques, which can be highly complex, and place very high demands on the accuracy of irradiation.

In general, even if radiation-induced injury risks are at a low level per each exposure, they have to be considered in a cumulative and long-term perspective: small individual costs, risks, and wastes multiplied by billions of examinations per year represent an important population, society and environmental burden (Picano, Santoro, & Vano, 2007).

Moreover, these risks take many forms:

**Biorisks.** The most common are: fatal cancer (Einstein, Henzlova, & Rajagopalan, 2007), infertility, progeria, low mental development, teratogenesis (Picano, 2004:a), increased rate of somatic DNA damage (Andreassi et al., 2006), allergic and life-threatening reactions (Picano, 2009), skin erythema, epilation, or cataract formation (Semelka, Armao, Elias, & Huda, 2007). Many data show an increased risk of breast cancer in female patients who undergo serial (spine) x-ray examinations, and that radiation doses on the order of 10 mGy received by the fetus in utero produce a consequential increase in the risk of childhood cancer.
On the other side, the careful selection of patients for CT and the careful optimization of scan protocol in patients referred for testing can help to minimize cancer risk (Einstein et al., 2007). The precise risk depends on the type of test, age and gender. The risk increases with decreasing age and – for any given age – it is higher in female gender. In particular, children are at substantially higher risk than adults, since they have more rapidly dividing cells and a greater life expectancy (Correia, Hellies, & Andreassi, 2005). In fact, radiation-induced malignancies have a biological latency of approximately 10 to 40 years (Gerber, Carr, & Arai, 2009). Obviously, it is important to weigh the hypothetical risk of inducing malignancies against the risks of not performing an imaging study, which may include misdiagnoses and failure to administer treatments that could improve medical outcomes.

**Economic costs.** Expenses for medical imaging are today one of the highest cost items in a National Health Service plan’s medical budget and they are also one of the fastest growing, raising the waste of resources (Picano, Pasanisi, Brown, & Marwick, 2007:a). In 1983, the International Commission on Radiological Protection (ICRP) issued a publication titled *Cost Benefit Analysis in the Optimization of Radiation protection – Publication 37* which should serve as a framework for describing how any expenses involved - in terms of money, time spent by personnel, dose received, etc. - when balanced with the expected benefits, could play a major role in the decision-making process for optimizing radiation protection. In other words, the basic principle behind this cost-benefit ratio is to select a protective measure that results in a net benefit that exceeds the next best alternative. The most common method of selecting a protective measure is to assign a dollar cost for a specific dose reduction: for example, the range of costs that have been considered to balance the cost versus risk is normally $200 to $2500 per person-rem reduction in collective dose. Many have argued that much of the care currently delivered is not efficient, as the extra money invested
in National Health Services have failed to make much difference to patients (Fleming, 2009), while both the MedPAC commission and other third-party payers have expressed concern about rapid rates of growth in these services (Gibbons, Miller, & Hodge, 2008), which is one of the highest cost items in a health plan's medical budget. Booz Allen Hamilton projected that spending on diagnostic imaging could grow 28% by 2005, with utilization growing by 9% per year (Picano, 2005). If this trend does not invert, the current crisis will soon worsen: in fact, the most common solution to rising healthcare costs is to restrict resources and ration services.

Social and public health. As Picano focused (2005), useless examinations restrict access to patients in real need (excessively delaying the waiting lists for patient needing the examination/public health services, which are unable to afford well-timed treatments), and do not increase (and possibly reduce) the quality of health care, that is inefficiency in improving health care standards. These demographic trends will dramatically increase cardiovascular disease and stroke, as these are diseases that are much more common in the elderly (Gibbons, 2007).

Ecological/environmental impact and radiation pollution. The medical use of radiation is the largest man-made source of radiation exposure (Picano, Vano, Semelka, & Regulla, 2007). The medical sources of radiation were about one fifth of the natural radiation in 1987, close to one-half in 1993, and almost 100% of natural radiation in 1997, and the use of procedures with a high load of radiation continues to grow steadily (Picano, 2005). About 5 billion imaging examinations are performed worldwide each year, and 2 out of 3 employ ionizing radiations with radiology or nuclear medicine (Picano, 2004:b). In the developed countries, exposure from medical ionizing test results in a mean effective dose per year per head in the range of 100 (Germany, radiological year 1997) to 160 chest x-rays (USA, radiological year 2006) – an amount higher than that originating from one year of natural background radiation (See Figure 1).
Organizational overload. As Kellermann (2006) demonstrated, health care is an overburdened system which is rapidly approaching its limits, with more patients needing care and fewer resources to care for them. He reports that when a hospital is full, emergency department patients who need inpatient care are “boarded” in exam rooms or hallways until an inpatient bed is available. Boarding ties up space, equipment, and personnel that would otherwise be available to meet the needs of incoming patients. Critically ill patients often wait the longest for admission, because beds in the intensive care unit are in particularly short supply. This rises the costs of uncompensated care and fear of legal liability for treating high-risk patients (which leads to the practice of defensive medicine), with a general increase of organizational failure.
Causes Of Inappropriateness

Even if appropriateness in imaging studies is recognized as an important feature in National Health Services, in Picano et al. (2007:a) diagnostic examinations are found to be definitely appropriate in 62%, probably appropriate in 10%, probably inappropriate in 22%, and definitely inappropriate in 6% patients, where inappropriateness stays for two classes: useless first-line test (over-investigation and/or inappropriate selection) and test repeated too often in the absence of change in clinical status (inadequate clinical utilization of test results).

So, why inappropriateness is still high in medical practices? There are different reasons why the problem of inappropriateness is still so widely ignored. They can be summerized in a series of factors, as it follows: definition of appropriateness, underestimation of long-term risks, unawareness, loss of communication, Ulysses syndrome.

Defining Appropriateness On Practical Grounds

Generally speaking, “appropriateness criteria” for imaging evaluate the benefits and risks of an imaging study for a specific indication, in order to determine whether it is “reasonable” to perform the study or not (Patel et al., 2005). So, a definition of an imaging test’s appropriateness must include test performance characteristics for a clinical indication, the potential negative consequences of imaging, an understanding of the implicit impact of cost on clinical decision making, and an explicit understanding of how the test results might lead to care that could improve the patient’s chances for better survival or improved health status.

Unfortunately, despite the clear need, the definition of appropriateness is obvious in theory, but not so straightforward on practical grounds (Picano, 2009).
In 2001 a group from the RAND Corporation, in collaboration with researchers from the University of California, Los Angeles (UCLA), initially described a method, called the RAND/UCLA Appropriateness Method, based on 4 steps, which should be repeated for each cardiovascular imaging modality: (I) develop list of specific clinical indications and review literature for an imaging modality; (II) expert panel review of clinical indications and ratings; (III) expert panel meeting and discussion followed by re-ratings; (IV) tabulation of appropriateness recommendations for one imaging modality across multiple indications. Interpretation and context of the final appropriateness scores leads clinicians and payers to be faced with a list of clinical indications for a single imaging modality that are deemed appropriate with scores of 7 to 9, uncertain with scores of 4 to 6, and inappropriate with scores of 1 to 3 (see Figure 2).

<table>
<thead>
<tr>
<th>Appropriateness Designation</th>
<th>Score</th>
<th>AHA/ACC Rec.</th>
<th>Level of Evidence</th>
<th>Additional Published Characteristics of Appropriate Imaging Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate</td>
<td>9</td>
<td>I</td>
<td>A – B</td>
<td>• Wide spectrum of patients studied</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>IIa</td>
<td>C</td>
<td>• No patient selection bias (consecutive)</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>IIb</td>
<td></td>
<td>• All patient image results verified (“gold standard” or prognosis)</td>
</tr>
<tr>
<td>Uncertain</td>
<td>6</td>
<td>IIb</td>
<td>B - C</td>
<td>• Blinded interpretation</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td>• Reproducible acquisition and interpretation</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriate</td>
<td>3</td>
<td>III</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>A - B</td>
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<td></td>
<td>1</td>
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Figure 2: Determining appropriateness score - guides for panel reviewers to consider.

However, this method is found to have different weaknesses (Patel et al., 2005): in fact, unlike procedures where there is a defined therapeutic benefit, imaging studies are performed with different goals in mind. Each of these goals is tied to specific clinical situations and often includes patient-level factors and test characteristics associated with the imaging modality. Additionally, imaging studies may have negative consequences, such as poor specificity with a high number of false positives leading to unwarranted further procedures or tests. Such risks and costs are generally not factored into the definition of procedural appropriateness, yet these factors have an obvious impact upon selecting an imaging modality and determining whether it is needed. Finally, it is believed that the perspective for the determination of appropriateness should be that of the patient. Then, the evaluation should seek to determine how the information gained from the cardiovascular imaging study will influence subsequent care to improve patient outcomes including survival and health status (a patient’s symptoms, function, and quality of life).

For these reasons, in 2005, the American College of Cardiology Foundation (ACCF) Appropriateness Criteria Working Group, in collaboration with the American Society of Nuclear Cardiology (ASNC), developed a method (officially supported by the American Hearth Association) for evaluating the appropriateness of cardiovascular imaging that, for a single modality, states that:

an appropriate imaging study is one in which the expected incremental information, combined with clinical judgement, exceeds any expected negative consequences by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication. (Brindis et al., 2005, p.1589)

Attempting to apply the ACCF/ASNC appropriateness criteria for SPECT perfusion imaging to current clinical practice in an academic medical center (Mayo Clinic Rochester) and to determine what percentage of patients were not included in the same criteria, Gibbons
et al. (2008) found that the ACCF/ASNC appropriateness criteria apply to approximately 90% of current stress imaging patients in their center: they suggest further refinements (in terms of an established database or detailed data collection, as well as a number of assumptions) in the criteria, particularly to the indications for follow-up testing, should be expected to reduce this number, but likely it is very difficult.

So, unlike prevention and treatment strategies supported by evidence-based practice guidelines, the evidence base for imaging is anecdotal, fragmented, and lacking in prospective clinical trials, as the parameters by which ionizing radiation is quantified differ among imaging modalities (Gerber et al., 2009). As a consequence, the process for developing appropriateness criteria is only partially evidence-based and is heavily weighted by expert consensus (Picano, 2009).

**Underestimation Of Long-term Risks And Uncorrect Radiological Doses**

As Picano focused (2004:a), to estimate radiation exposure it is generally used the 2000 report by the United Nations Scientific Committee on the Effects of Atomic Radiation, which refers to the years 1991–96 (in the mid-1990s, CT scanning accounted for about 4% of procedures and about 40% of the collective dose in radiology; now, CT scanning in large hospitals accounts for about 15% of procedures and 75% of the diagnostic radiation dose received by patients) and does not consider the practice of nuclear medicine, which adds a further 10% to the global radiation burden (Picano, 2005).

However, there are many objections about the possibility of a world-wide and updated study about the influence on radiation exposure (Picano, 2004:a):

(a) it should be necessary a more than 5 million people study in order to quantify directly the risk of cancer from exposure to doses or radiations typically delivered by
diagnostic x-rays. In particular, more data are needed to better understand the genetic, immunological and environmental factors modulating low dose radiation damage (Picano et al., 2007:c);

(b) x-rays are helpful in early detections of some cancers;

(c) a formal risk/benefit analysis would require detailed studies for each type of diagnostic x-ray;

(d) the concept of effective dose, which is the best single parameter for quantifying how much radiation an individual will receive during any radiologic examination, is often misunderstood as a parameter that can be measured directly and quantified precisely and that is patient-specific. First, the radiation doses received by individual organs (organ dose) are estimated with standardized mathematical models of the human body with the characteristics of male and female torsos with standardized organ size, mass, and geometry. Second, the relative biological effectiveness of ionizing radiation is represented by a radiation weighting factor that differs depending on the type and energy of radiation. Third, the radiation sensitivity of each organ or tissue is represented by tissue-specific weighting factors. Thus, estimates for effective dose can differ substantially on the basis of definitional changes alone, even if the actual radiation exposure was identical. And the difficulties related to the changing definitions and methodologies of the estimation of effective dose also apply in nuclear medicine. Therefore, the reality is that quantitative certainty does not exist.

**Unawareness Concerning The Basic Principles Of Diagnostic Procedures**

The core principle governing the use of ionizing radiation is ALARA (As Low As Reasonably Achievable) (Hirshfeld et al., 2005), which recognizes that there is no magnitude of radiation exposure that is known to be completely safe, and it is based on the assumption
that any radiation exposure, no matter how small, carries with it a certain level of risk that is proportional to the level of exposure. This hypothesis is known as the linear, non-threshold hypothesis, or LNT (UW Environmental Health and Safety, 1999).

Because of this finding, both the American Department Of Energy and Nuclear Regulatory Commission (NRC), for a number of years, have required an ALARA program at nuclear facilities, based on the key concepts of: justification, optimization, and dose limitation (Health Physics Society, 2009).

*Justification* means, according to a risk/benefits approach, that any proposed activity that may cause exposure to persons should yield a sufficient benefit to society to justify the risks incurred by the radiation exposure. An example of an activity that was considered unjustified was the now-discontinued practice of fitting shoes to people's feet using x rays. The exposure resulting from this activity was considered to be unjustified, and the practice was discontinued.

*Optimization*, which is also known as the proper practice of ALARA, means that the radiation exposures resulting from the practice must be reduced to the lowest level possible considering the cost of such a reduction in dose. Optimization, or ALARA, is required by nearly all licensing agencies, including the NRC.

*Limitation* involves setting upper limits on the dose that may be received by any member of the public from all man-made exposures other than medical exposures. These limits are imposed by regulatory agencies.

Then, the ALARA principle confers a responsibility on all physicians to minimize, in case selection and in procedure conduct decisions, the radiation injury hazard to their patients, to their professional staff, and to themselves: applying it appropriately in the interest of
patient and clinical staff protection should be viewed as a standard of care (UW Environmental Health and Safety, 1999).

On these basis, according to the Euratom law, both the prescriber and the practitioner are responsible for the justification of the test exposing the patient to a potential risk. In particular, European Commission forbid unjustified exposure and clearly state that a non-ionizing examination should always be preferred to a ionizing one, when the information provided is comparable: in fact, higher doses translate into higher risks and the risk is cumulative, meaning that when several tests or procedures are performed, dose is added to dose and risk to risk. The 97/43 Euratom directive for nuclear medicine establishes that indication and execution of diagnostic procedures should follow three basic principles: the justification principle (article 3: “if an exposure cannot be justified, it should be prohibited”), the optimization principle (article 4: “according to the ALARA principle, all doses due to medical exposures must be kept As Low As Reasonably Achievable”), and the responsibility principle (article 5: “both the referring physician ordering the nuclear medicine test [the prescriber] and the nuclear medicine physician [the practitioner] are responsible for the justification of the test exposing the patient to ionizing radiation”). Any responsible prescription of a nuclear cardiology test today should follow these principles (Picano, 2003). If the information is comparable, every effort should be done to orient the patient towards non-ionizing testing: doses and risks associated with the different diagnostic options should be clearly spelled out to allow the patient and the prescriber to make an informed decision. Unfortunately, as Lee et. al (2004), Thomas et al. (2006) and Benedetti et al. (2008) demonstrate, both patients/general population and physicians/medical practitioners are generally unaware of the potential harmful effects of the inappropriate use of diagnostic medical procedures in terms of differential costs, radiological doses, and long term risks of
different imaging modalities. The physicians and imaging specialists, without differences of age, rank, speciality and gender (Correia et al., 2005) largely continue to prescribe and/or perform daily a significant number of medical examinations based on ionizing testing. And the more they do, the more they tend to ignore the dose and the risk of what they do (Picano, 2005). According to Correia et al. (2005), only 5% of the polled physicians exactly estimate the biorisks of radiation tests, while legal regulation of prescription is correctly perceived by 42% of polled physicians (Picano, 2005).

Radiological ignorance increases if you consider that 1 out of 20 doctors does not realize that ultrasound does not use ionizing radiation, that 1 out of 10 does not realize that magnetic resonance imaging does not use ionizing radiation. This demonstrate that more intense use of ionizing testing is not associated to higher awareness, while unawareness generates inappropriateness.

**Loss Of Communication And Imperfect Exchange Of Information**

In a 2004 study of health policies and practices in radiology, Lee et al. considered adult patients who were seen in the emergency department of a U.S. academic medical center for mild to moderate abdominopelvic or flank pain and underwent a CT investigation. Only 7% (5 to 76) of the patients stated that they were informed about the risks and benefits of a CT scan; of even greater concern are data showing that the radiologists who performed the CT examinations considered the radiation exposure to be of limited importance.

This means that, despite the current evidence regarding the risk of low-dose radiation offered by radiation biologists, there is a lack of information transfer even between researchers and clinicians, including radiologists, which induces inappropriateness (Picano et al., 2007:a) and damages safety and accuracy of the medical procedures themselves (Picano et
Basic radiological information is often difficult to find and to understand: there is an obscure and non-standardized terminology that makes it difficult for researchers – not to mention clinicians – to really understand the dose and the risks associated to the procedure he or she is using.

Radiological awareness and communication between health-care providers and radiologists are essential to help doctors in the difficult task of balancing what is good for the individual patient against what is acceptable for society and of determining whether an imaging study is appropriate (RSNA Professional Committee, 2006). Radiological protection should come to mean, not just another form to fill in, but a way of thinking, so that long term risk is familiar to doctors and patients and can be appropriately balanced against acute diagnostic benefits (Picano, 2004:c).

Supplied with sufficient clinical information, the radiologist may be able to suggest an acceptable alternative that does not use ionizing radiation, such as magnetic resonance imaging or ultrasound. Dialogue between the referring physician and the radiologist is essential, especially given a generally uninformed medical community with inadequate knowledge about radiation exposure.

Moreover, any discussion of risk between the patients and the physicians is complicated by psychological and linguistic barriers.

The first kind of barrier can be summarized using Festinger’s (1957) Cognitive Dissonance theory: in many circumstances, informing involved people about certain risks does not necessarily induce them to change behaviour in the direction of decreasing those risks. In those cases in which people experience a dissonance among their behaviour (the act of taking a risk) and their cognitions (the knowledge that the risk is very high), they usually
choose to reduce the discomfort by changing their cognitions (e.g. they start to think that data about that risk are not reliable), because it is generally easier than modifying a behaviour.

Another problem is in risk perception: people tend to underestimate large risks (such as the risk of dying from smoking tobacco) and overestimate small risks (such as that of being struck by lightning), and are more willing to accept higher risks in situations where they think (usually wrongly) that they are in control (such as driving a car rather than being a passenger in an airplane) (Picano, 2004:c).

Linguistic barriers are a matter of fact: the language of radiation protection is not readily understood by non-specialists, as it expresses radiation doses in an obscure lexicon made up of millicuries, microsieverts or millirems and risks as nominal probability coefficients for stochastic effects (Picano, 2004:c). This problem is even more serious if we consider mass communication, that is communication toward general public with a very basic notions in medicine and a very high heed to mass media. In fact, in light of recent media coverage focusing on the increased risk of cancer from CT scans, patients have become more concerned about the increased use of medical imaging, and are progressively more asking for information about their risk. Whether or not increased cancer risk exists, the disproportion in opinions between radiologists and non-radiologists revealed by Lee et al. (2004) suggests that current information regarding possible radiation-related risks is not being disseminated from the radiology community to either requesting physicians or patients.

The Ulysses Syndrome

According to Semelka et al. (2007) marketing messages, economic induction (for example, monetary incentives to perform more CT studies related to fee-for-service financial arrangements), professional interest, high patient demand and defensive medicine, that is the
overcautious ordering patterns of referring physicians with concerns related to potential malpractice litigation, lead to a sort of "paradox of plenty", where more resource use lead to poorer measures of care: the evolution of technology did not bring a parallel increase in the maturity in using it (Picano, 2004:b) and the quality of care, but rather an increase in cost (Picano, 2005).

More is not necessarily better and, in fact, may be worse: this teaches the vicious circle of the so-called *Ulysses syndrome* (first described in 1972 by Canadian physician Dr. Mercer Rang, who applied it to the ill effects of extensive diagnostic investigations conducted because of a false-positive or indeterminate result in the course of a routine laboratory screening), as a metaphor for the diagnostic pathway (remember: none of the considered diagnostic examinations are free, and each implies a financial and a safely cost) of the patient with suspected coronary artery disease. The result of this Odiseey are very interesting:

(a) just at the end of the first round of the journey, the cumulative cost is more than 100 times a simple exercise-electrocardiography, and the cumulative radiation dose is that of more than 4,000 chest x-rays;

(b) the patient, who at first accept enthusiastically these tests since he read the front page and cover story of a magazine explaining that in this way you can detect asymptomatic life-threatening coronary artery stenosis, is becoming increasingly anxious;

(c) the invasive and interventional procedures that he received did not improve his quality of life since he was asymptomatic at he beginning of his cardiological history and the anatomy-driven revascularization will not increase his life expectancy. Periodic follow-up examinations with imaging testing will be scheduled - mostly inappropriately- and the Odyssey will last probably forever (Picano, 2004:b).
Discussion

While the need for education for all stakeholders in the principles of radiation safety and preferential use of alternative (non-ionizing) imaging techniques has clearly been established (Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, 2006), there are no clear focuses about two turning points: the *distribution* of information and the *language* of communication between physicians and patients, and this demonstrates that difficulties in the reduction of inappropriateness are mostly caused by a lack of awareness of, and training in, basic communication strategies.

In fact, there are no widely available resources that provide information to both patients and health care providers about the increased risks (cancer, teratogenesis, etc.) from medical imaging. Current information regarding radiation dose and possible associated risks should be made available to the general public to help ensure that all stakeholders, patients and healthcare providers, are aware of the information necessary to more accurately weigh the risks and benefits associated with diagnostic CT scans (Lee et al., 2004).

This information should at least be distributed to patients who are able to take the time (as they are not in emergency) and consider the information in light of their healthcare needs: dissemination of this material will be crucial to maintain the public trust in the radiology community as responsible caregivers.

Moreover, full disclosure of the current knowledge level about radiation dose and possible risks should be distributed in an appropriate language and in a manner that does not cause public panic. In this perspective, as suggested by other authors (Rothman et al., 2008; Schapira et al., 2008; VanGeest et al., 2010), enhanced measures of numeracy in the health care setting need to be studied and research on numeracy should allow the advancement of
interventions addressed to patients with inadequate numeracy skills, primarily in risk communication.

Due to the objective of the study, basic theories about communication and cognitive psychology (i.e., how to be aware of and to communicate risk, Cognitive Dissonance theory, Ulysses syndrome, etc.) have not been discussed, but just quoted, and therefore it should be difficult to understand how much useful they are to the aim of reducing inappropriateness.

**Conclusions and further research**

The results of this literature review demonstrate that, if we really want to reduce inappropriateness in ionizing imaging, we need a different state of mind, under many viewpoints:

(a) We have to adopt a qualitative assessment, replacing the quantitative one: the current health system pays for volume of procedures regardless of their appropriateness. New payment models should be developed to pay physicians more for providing clearly appropriate procedures and substantially less for procedures of limited value (Picano et al., 2007:a). However, how to measure and improve quality?

(b) We must look beyond short-term concerns in the interest of long-term progress (Gibbons, 2007).

(c) We have to reinforce commitment and managerial cognition, in order to influence the way physicians and patients manage their joint decision-making process (Kellerman, 2006).

(d) We have to promote inter-institutional cooperation and to reinforce education, both on the physicians and the patients, in order to improve their understanding of the key-
concepts of appropriateness and to promote a constant and real dialogue between them using a clear, simple, common-use language (Lee et al., 2004).

(e) In parallel with studies aiming to rise awareness about ionising imaging risks, we propose that future research on health communication should include cognitive dissonance applications to change behaviour in both patients and physicians towards decreasing medical radiation risks, within decision-making and informed consent processes.

In order to support physicians and National Health Services in their challenging tasks and to develop more efficient strategies to reduce inappropriateness, more studies should investigate organizational, communicational, psychological, and personnel-related factors, gaining commitment to these themes, and improving communicational fluxes, on the base of constructive feedbacks.
References


