RADIOPROTECTION & FORMATION

DEVELOPPRER LES COMPETENCES ET LA CULTURE IN RADIOPROTECTION

Paris, 14 & 15 Juin 2016

APPLICATION DE L'ANALYSE DES MODES DE DÉFAILLANCE ET DE LEURS EFFETS (AMDE) EN RADIOTHÉRAPIE POUR UNE ÉVALUATION PROACTIVE DES RISQUES

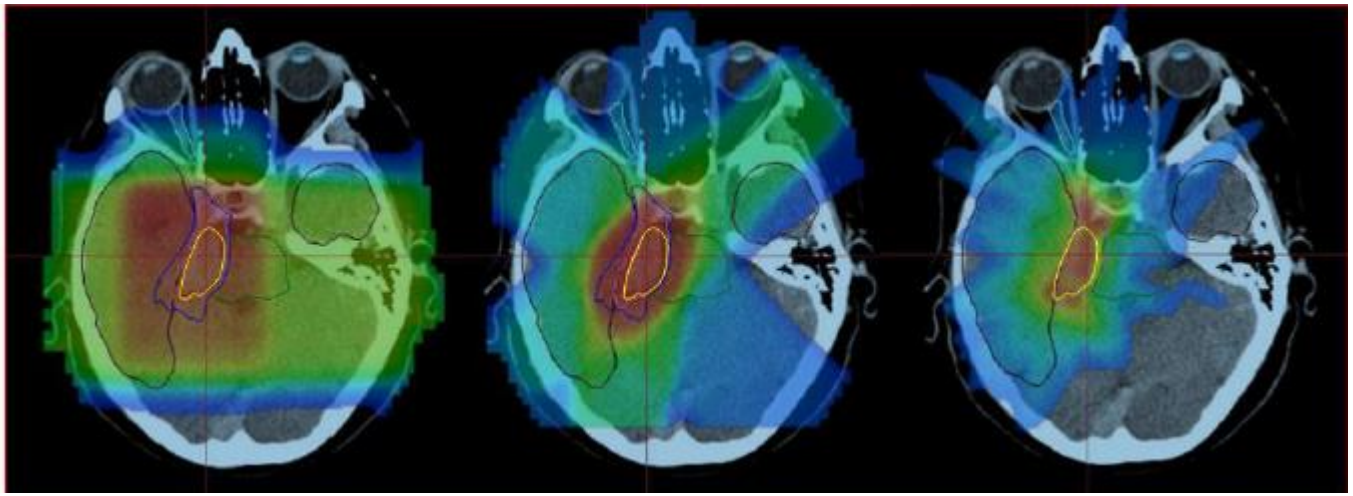
Marie Claire Cantone

Università di Milano

Ces dix dernières années, le développement de la radiothérapie (RT) a été particulièrement significatif

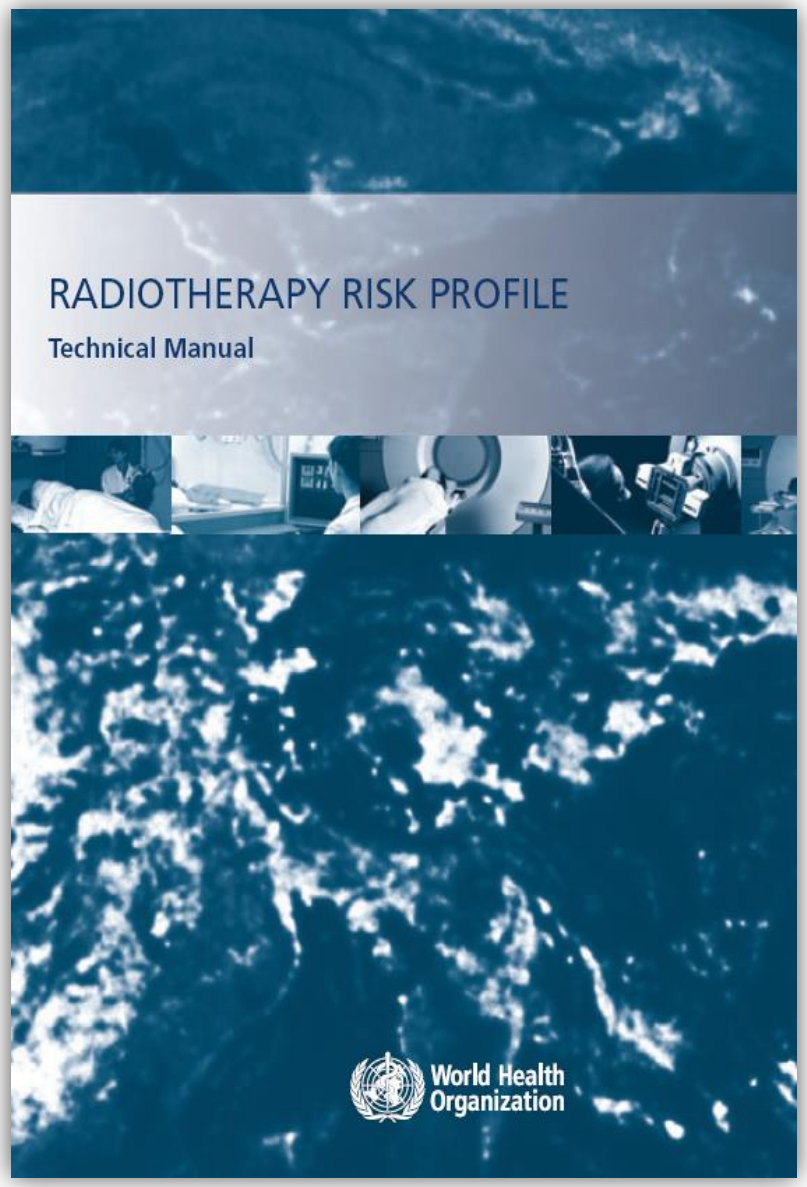
Les développements de la technologie de l'imagerie associée aux progrès de la technologie de l'informatique ont radicalement modifié les processus de ciblage des tumeurs ainsi que la planification de la radiothérapie.

meilleure distribution des doses
niveau de complexité beaucoup plus élevé



K. Bénézery, 2014

2D **3D CRT** **IMRT**



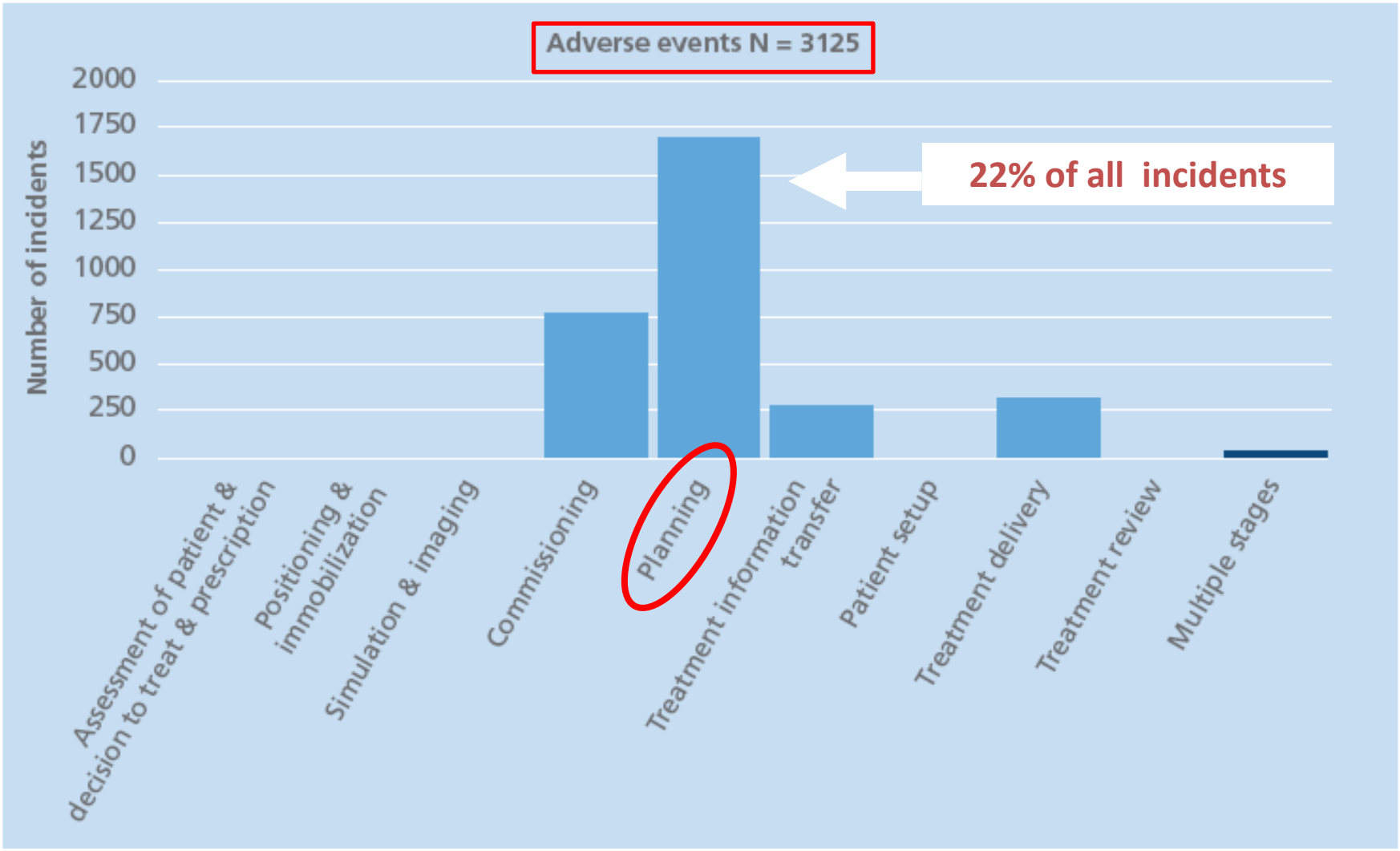
"Radiotherapy is widely known to be one of the safest areas of modern medicine, yet, for some, this essential treatment can bring harm, personal tragedy and even death "

RADIOTHERAPY RISK PROFILE
Technical Manual - W H O, 2008

Résumé chronologique des incidents de radiothérapie avec des événements indésirables par pays et le stade de traitement (OMS, 2008)

Year(s)	Country	Economic group	Stage of therapy	Cause/contributing factors of error	Outcome/impact	Number affected
1999–2003	Japan	High income	Planning	Output factor input error in renewal of treatment planning system	Radiation underdose	31
1999–2004			Treatment delivery	Insufficient dose delivery caused by an incorrect operation of dosimeter	Radiation underdose	256
2000–2001	Panama	Upper middle income	Planning	Error shielding block related data entry into TPS resulted in prolonged treatment time	Radiation overdose toxicity Patient deaths due to overdose	28 11
2001	Poland	Upper middle income	Treatment delivery	Failure of safety system on a Linac after power failure	Radiation overdose toxicity	5
2003	Japan	High income	Planning & Information transfer	Input error of combination of transfer total dose and fraction number	Patient death suspected due to overdose	1
2003–2004			Planning &	Misapplication of tray factor	Radiation overdose toxicity	25
2004–2005				accelerator after introduction of new treatment planning system (TPS) (static wedges changes to dynamic wedges but dose intensity modification not done)	Patient deaths due to overdose	5
			Information transfer & Treatment delivery	Miscommunication of field size estimation, error in patient identification, incorrect implantation of source during brachytherapy	Radiation overdose toxicity Patient death due to overdose Unknown health consequence	2 1 5
2004–2007	Canada	High income	Planning	Incorrect output determinations for field sizes other than the calibration field size for superficial skin treatments.	Radiation underdose by 3-17% Unknown health consequences	326

Radiotherapy incidents (1976-2007) by the stages of treatment process (WHO, 2008)



Une plus grande complexité pose de nouvelles exigences en ce qui concerne les programmes de MQ

L'approche rétrospective des risques - approche prescriptive - est d'une grande valeur, mais elle est intrinsèquement limitée.

- L'analyse des risques n'a pas effectuée avant qu'un accident ait lieu, ou une quasi-accident.
- Il y a des accidents potentiels qui ne sont pas encore arrivées, mais qui peuvent se produire, et d'autres qui ont eu lieu, mais qui ne sont pas signalés.
- Compte-tenu de la complexité une approche englobant tous les tests et contrôles possibles peut pas être appliquée, dans un contexte de temps et de ressources limitées.

Une plus grande complexité pose de nouvelles exigences en ce qui concerne les programmes de MQ

L'approche prospective des risques - approche proactive -
La méthode est basée sur un processus structuré pour identifier les faiblesses du système, et contribue à:

- anticiper les défaillances potentielles
- sélectionner les contrôles dans une façon rationnelle
- définir une répartition adéquate des ressources

Les méthodes proactives ne peuvent être utilisées pour remplacer totalement les méthodes rétrospectives, mais plutôt pour renforcer et intégrer ces approches de manière synergique afin d'améliorer la sécurité globale du traitement RT.

“retrospective approaches are not sufficient and all-inclusive quality control checks may not be feasible”



ICRP Publication 112



Preventing Accidental Exposures from New External Beam Radiation Therapy Technologies

ICRP PUBLICATION 112

Approved by the Commission in September 2009

Published: JUN-2010

Un groupe de travail Italien sur l'approche prospective a été lancé pour la prévention des risques dans les nouvelles technologies RT (2010)

Association Italienne de Physique Médicale

Obectif

Présenter et promouvoir une approche prospective pour réduire les expositions accidentelles en RT: c'est-à-dire pour développer une approche structurée pour la gestion des risques par l'identification et l'analyse de analyse des événements indésirables et leur gravité potentielle, dans les différentes phases du processus RT.

Base

L'idée, à l'origine, n'a pas été motivée par une préoccupation particulière sur la sécurité des patients, liée à un événement local ou national, mais juste par une attention tout à fait conscient de la complexité intrinsèque des technologies telles que l'IMRT et par la nécessité de contribuer à élargir le terrain de la prévention des incidents et accidents dans ce domaine.

Ateliers et cours ont été organisés sur la sécurité du patient dans la radiothérapie moderne: l'approche prospective



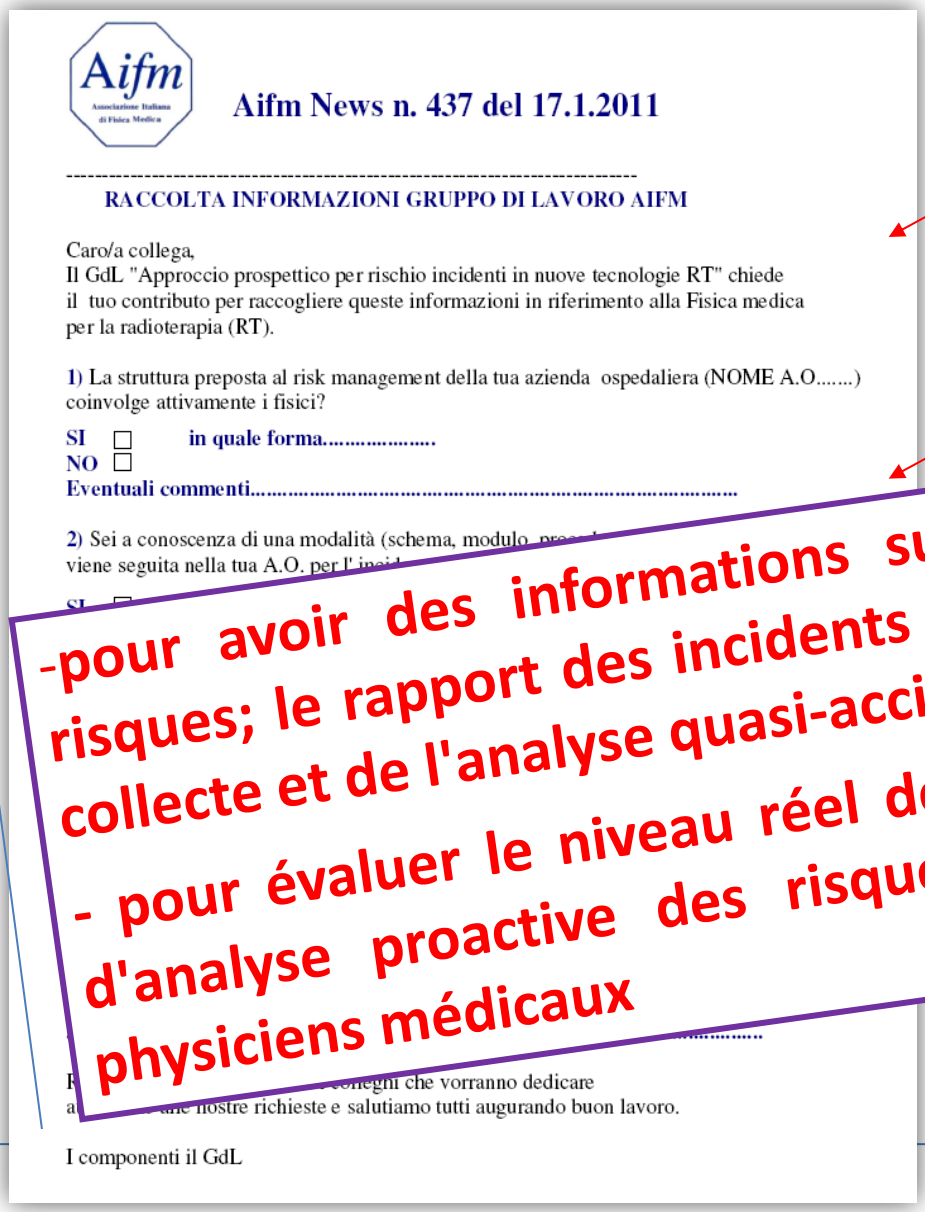








Un questionnaire a été distribué aux physiciens médicaux travaillant dans les ministères RT



Aifm

Aifm News n. 437 del 17.1.2011

RACCOLTA INFORMAZIONI GRUPPO DI LAVORO AIFM

Caro/a collega,
Il GdL "Approccio prospettico per rischio incidenti in nuove tecnologie RT" chiede il tuo contributo per raccogliere queste informazioni in riferimento alla Fisica medica per la radioterapia (RT).

1) La struttura preposta al risk management della tua azienda ospedaliera (NOME A.O.....) coinvolge attivamente i fisici?

SI ☐ in quale forma.....
NO ☐
Eventuali commenti.....

2) Sei a conoscenza di una modalità (schema, modulo, proc...
viene seguita nella tua A.O. per l'inci...
SI ☐

...colleghi che vorranno dedicare
...alle nostre richieste e salutiamo tutti augurando buon lavoro.

I componenti il GdL

Is the physicist engaged in the risk management processes ?

Is the physicist aware about :

- **procedures ...**
- **...tional QA**

-pour avoir des informations sur: le processus de gestion des risques; le rapport des incidents possible en RT; les procédures de collecte et de l'analyse quasi-accidents.

- pour évaluer le niveau réel de l'expérience dans l'utilisation de d'analyse proactive des risques dans la RT moderne par des physiciens médicaux

Un questionnaire a été distribué aux physiciens médicaux travaillant dans les ministères RT

Aifm
Associazione Italiana di Fisica Medica

Aifm News n. 437 del 17.1.2011

RACCOLTA INFORMAZIONI GRUPPO DI LAVORO AIFM

Caro/a collega,
Il GdL "Approccio prospettico per rischio incidenti in nuove tecnologie RT" chiede il tuo contributo per raccogliere queste informazioni in riferimento alla Fisica medica per la radioterapia (RT).

1) La struttura preposta al risk management della tua azienda ospedaliera (NOME A.O.....) coinvolge attivamente i fisici?

SI ☐ **in quale forma.....**
NO ☐
Eventuali commenti.....

2) Sei a conoscenza di una modalità (schema, modulo, procedura) che viene seguita nella tua A.O. per l' incident reporting in RT?

SI ☐
NO ☐
Eventuali commenti

3) Sei a c
che viene

SI ☐
NO ☐
Eventuali c

4) Sei a conc
in RT (FMEA
di qualità?

.....

.....

Ringraziamo in anticipo tutti i colleghi che vorranno dedicare attenzione alle nostre richieste e salutiamo tutti augurando buon lavoro.

I componenti il GdL

Prospective approaches for risk analysis in modern radiotherapy: the Italian experience and the contribution of medical physicists

L. Begnozzi[1], M.C. Cantone[2a], B. Longobardi[3] and I. Veronese[2]

SFRP

Radioprotection 49 (1), 43-47 (2014)

Is the physicist engaged in the risk management processes ?

Is the physicist aware about :

- **procedures of *incident reporting i***
- **(FMEA etc..) besides traditional QA**

Rapport sur l'analyse des principales questions, des approches prospectives et discussion des cas d'accidents



pp. 1-127

Report AIFM
N.8 (2012)

Approccio prospettico alla sicurezza del paziente nella moderna RT

Coordinatore del Gruppo di lavoro
Marie Claire Cantone, Università di Milano

Documento predisposto da:

Luisa Begnozzi, Ospedale San Giovanni Calibita Fatebenefratelli, Roma
Marie Claire Cantone, Università di Milano, Milano
Mario Ciocca, Centro Nazionale di Adroterapia, Pavia
Barbara Longobardi, IRCCS, Ospedale S. Raffaele, Milano
Silvia Molinelli, Centro Nazionale di Adroterapia, Pavia
Chiara Pellegrini, Istituto Clinico Humanitas, Rozzano
Giovanna Sartor, CRO, Aviano
Antonella Soriani, IFO Ist. Regina Elena, Lab. Fisica Medica, Roma
Luigi Spiazzi, A.O. Spedali Civili, Brescia
Valeria Tremolada, A.O. S. Gerardo, Monza
Ivan Veronese, Università di Milano, Milano
Viviana Vitolo, Centro Nazionale di Adroterapia, Pavia

A cura del Gruppo di Lavoro
Approccio Prospettico per rischio incidenti in nuove tecnologie RT

Aifm
Associazione Italiana di Fisica Medica

Roma, 24 settembre 2012 , ISBN 978-88-907973-0-9

Analyse des Modes de Défaillance et de leurs Effets (AMDE) : approach prospective

- Choix du processus y définition de l'équipe de travail
- Analyse du processus pour identifier les différentes actions et sous-processus
- Identification de tous les modes de défaillance possibles (MD)
- Identification de toutes les causes possibles de chaque MD
- Détermination de l'impact de chaque MD **sur les résultats du processus**

Principales phases du processus de traitement RT



Analyse des Modes de Défaillance et de leurs Effets (AMDE) : approach prospective

Pour chaque étape d'un sous-processus, poser la question:

- ☑ Qu'est-ce qui pourrait tourner mal (***potentiel mode de défaillance***)
- ☑ Comment cela pourrait se produire (***quelles sont les causes pour un mode de défaillance***)
- ☑ Quels effets aurait une telle défaillance (***effets potentiels de défaillance***)

Le risque global pour chaque mode de défaillance identifié est évaluée en fonction du Indice de Priorité du Risque - IPR

Risk Priority Number (RPN)

Pour chaque étape d'un sous-processus

étape	potentiel mode de défaillance	causes de défaillance	effets potentiels de défaillance	P	G	D	IRP	commentaires
IPR = PxGxD		P, G, et D ont des valeurs 1→ 10						

P - Probabilité de l'évènement

G - Gravité des effets liés au mode de défaillance en cas de non détection y correction

D - Détectabilité, la probabilité que la défaillance n'ait pas été détectée

Pour chaque étape d'un sous-processus

Indice de Priorité du Risque

- **Un IPR de 125 ou plus est considéré avec attention en terme de sécurité**
- **Les cas avec des IPR plus grands doivent être traités avant**

Exemples de situations potentiellement cachées, à faible IPR

Probabilité =10 Gravité = 10 Détectabilité,=1 → IPR =100
Probabilité =1 Gravité = 10 Détectabilité,=10 → IPR =100

Gravité =10 → même si Probabilité et Détectabilité sont faibles, il est important de considérer le cas.

Un exemple de tableau pour les IPR (treatment planning in protontherapy)

Table 2 Application of failure mode and effects analysis for the treatment planning stage in proton beam radiotherapy

Sub-process	N	Potential failure mode	Potential causes of failure	Potential effects of failure
(I) Selection of the reference CT scan for planning	1	Error in selecting the CT scan (e.g. incorrect patient set up, outdated representation of the anatomy) in case of multiple CT scans	Human error, failure in the communication between operators	Wrong dose distribution/ wrong dose delivery
	2	Outdated representation of the anatomy (single CT scan)	Anatomical changes (related to time delay)	Wrong dose distribution/ wrong dose delivery
(III) Manual correction of external contour	3	Incorrect external contour definition (body or patient mask countour underestimation, i.e. not fully included in the external contour)	Human error	Wrong dose distribution / wrong dose delivery
	4	Failure of object/region identification	Human error	Wrong dose distribution
(IV) Delineation of CT artefacts, altered structures, metal implants and manual assignment of specific HU numbers	5	Inaccurate delineation	Human error	Wrong dose distribution
	6	Incorrect HU number manual assignment	Human error or lack of documentation from the referring clinicians (e.g. surgeons)	Wrong dose distribution

Cantone et al. Radiation Oncology, 2013

Un exemple de tableau pour les IPR (treatment planning in protontherapy)

Table 2 Application of failure mode and effects analysis for the treatment planning stage in proton beam radiotherapy

Sub-process	N	Potential failure mode	Potential causes of failure	Potential effects of failure	O	S	D	RPN
(I) Selection of the reference CT scan for planning	1	Error in selecting the CT scan (e.g. incorrect patient set up, outdated representation of the anatomy) in case of multiple CT scans	Human error, failure in the communication between operators	Wrong dose distribution/ wrong dose delivery	3	8	4	96
	2	Outdated representation of the anatomy (single CT scan)	Anatomical changes (related to time delay)	Wrong dose distribution/ wrong dose delivery	3	8	8	192
(III) Manual correction of external contour	3	Incorrect external contour definition (body or patient mask countour underestimation, i.e. not fully included in the external contour)	Human error	Wrong dose distribution / wrong dose delivery	4	5	4	80
	4	Failure of object/region identification	Human error	Wrong dose distribution	3	8	4	96
(IV) Delineation of CT artefacts, altered structures, metal implants and manual assignment of specific HU numbers	5	Inaccurate delineation	Human error	Wrong dose distribution	4	6	6	144
	6	Incorrect HU number manual assignment	Human error or lack of documentation from the referring clinicians (e.g. surgeons)	Wrong dose distribution	4	7	7	196

Cantone et al. Radiation Oncology, 2013

ELSEVIER

Int. J. Radiation Oncology Biol. Phys., Vol. 82, No. 2, pp. e305–e311, 2012
Copyright © 2012 Elsevier Inc.
Printed in the USA. All rights reserved
0360-3016/$ - see front matter

doi:10.1016/j.ijrobp.2011.05.010

PHYSICS CONTRIBUTION

APPLICATION OF FAILURE MODE AND EFFECTS ANALYSIS TO INTRAOPERATIVE RADIATION THERAPY USING MOBILE ELECTRON LINEAR ACCELERATORS

Mario Ciocca, M.S.,* Marie-Claire Cantone, Ph.D.,†‡ Ivan Veronese, Ph.D.,†‡
Federica Cattani, M.S.,§ Guido Pedroli, M.S.,§ Silvia Molinelli, M.S.,* Viviana Vitolo, M.D.,‖
and Roberto Orecchia, M.D.¶**††





Treatment delivery 24 sub-processes

Mesures de sécurité supplémentaires, en termes de sécurité des patients, pour améliorer la thérapie peropératoire (IORT)

- utilisation d'une double vérification indépendante de calcul des UM
- la mise en œuvre de l'utilisation extensive de la dosimétrie in vivo
- sélection d'un personnel dédié en charge des procédures de IORT



Treatment delivery

24 sub-processes

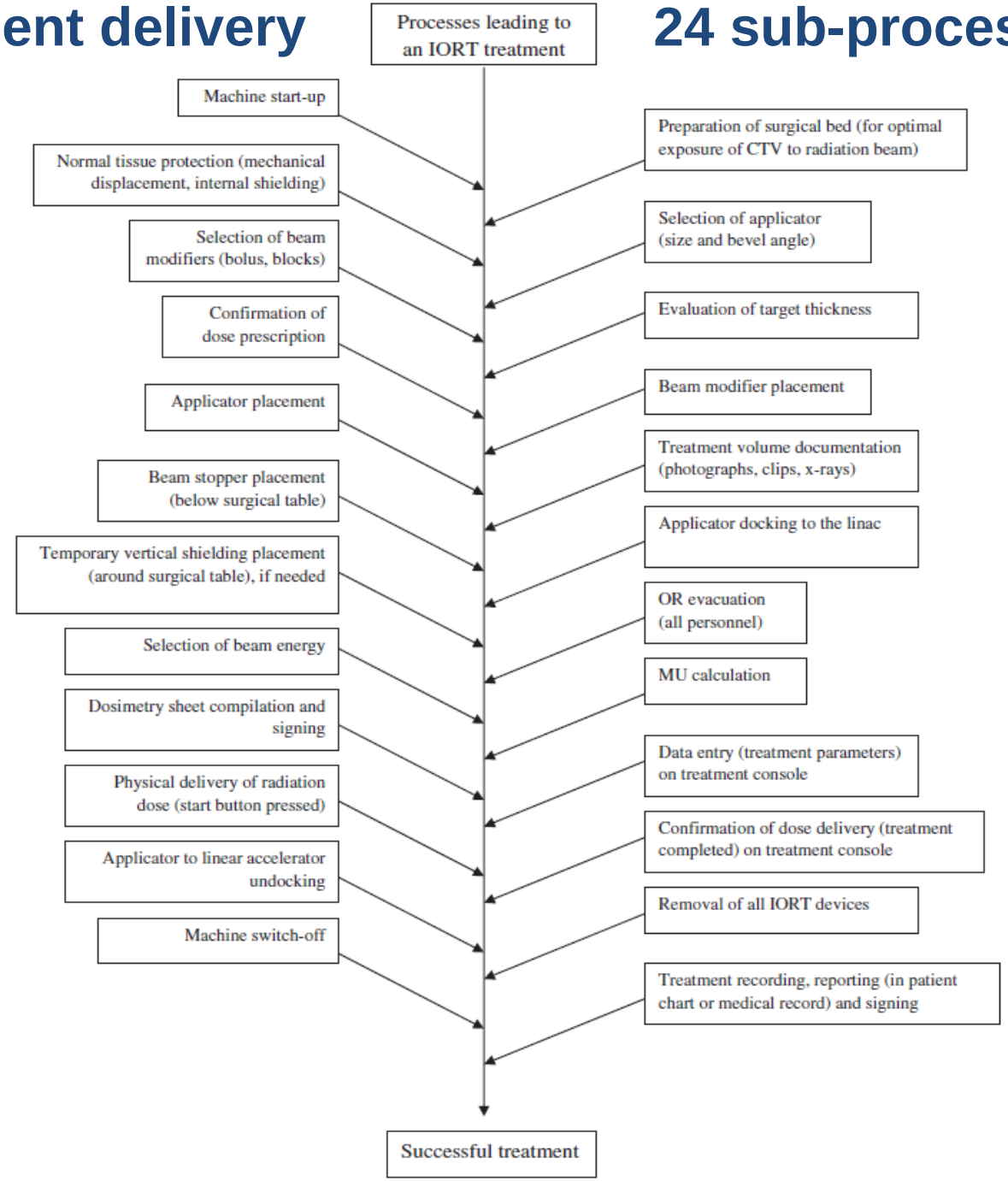


Table. Application of failure mode and effects analysis in IORT, for the stages "treatment delivery and verification"

Involved subprocess	Potential failure mode	Potential causes of failure	Potential effects of failure	O	S	D	RPN
Normal tissue protection	1) Wrong orientation of internal shield (for two-layered shields)	Human error in the placement of the shield	Wrong dose delivery and/or dose distribution	3 (1–4, 1.0)	5 (4–6, 0.9)	5 (4–6, 1.0)	75
Normal tissue protection; applicator placement	2) Misalignment of internal shield	Shield displacement, wrong applicator placement	Unintended normal tissue irradiation	9 (7–10, 0.9)	3 (2–4, 0.9)	8 (5–8, 1.3)	216
Selection of the applicator	3) Inadequate safety margins	Underestimation of CTV extension, inadequate selection of the applicator	CTV underdose	3 (2–5, 1.2)	8 (6–8, 0.8)	5 (5–7, 1.1)	120
Evaluation of target thickness; selection of beam energy	4) Inadequate energy selection	Human error in the measurement of target thickness or consultation of dosimetry atlas, failure in the communication between operators	CTV underdose or vice versa unintended normal tissue irradiation	2 (2–5, 1.2)	8 (6–8, 0.8)	7 (6–8, 0.8)	112
Applicator placement	5) Inadequate preparation of the area to be treated or inaccurate placement of the applicator base	Biologic fluid accumulation, tissue protrusion inside the applicator, air gap presence	Wrong dose delivery and/or dose distribution	3 (2–5, 1.3)	6 (5–7, 0.9)	5 (4–6, 0.8)	90
Applicator placement	6) Geographic miss of the CTV	Inadequate localization of the CTV; applicator displacement because of physiological movements	CTV underdose; unintended normal tissue irradiation	3 (2–5, 1.0)	3 (2–4, 0.8)	7 (6–8, 0.9)	63
Applicator docking to the linac	7) Inaccurate docking (for soft-docking systems)	Malfunctioning or tolerances of the alignment optical system	Wrong dose delivery and/or dose distribution	2 (1–3, 0.8)	3 (2–4,0.9)	7 (6–8, 0.9)	42
MU calculation	8) Wrong MU calculation	Human error in the calculation, failure in the communication between operators	Wrong dose delivery	2 (1–3, 0.8)	9 (7–9, 0.8)	8 (6–8, 0.9)	144
Data entry at the treatment console	9) Incorrect data entry at the treatment console (beam energy, MU, field size)	Human error in manual data entry, failure in the communication between operators	Wrong dose delivery and/or dose distribution	2 (1–3, 0.9)	9 (8–9, 0.7)	8 (7–9, 0.9)	144
Physical delivery of radiation dose	10) Undetected failure of the linear accelerator	Linear accelerator malfunctioning, or operated in physics	Wrong dose delivery and/or dose distribution	2 (1–2, 0.8)	6 (6–8, 0.9)	8 (7–9, 0.9)	96

JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 14, NUMBER 5, 2013

Application of failure mode and effects analysis (FMEA) to pretreatment phases in tomotherapy

Sara Broggi,[1] Marie Claire Cantone,[2] Anna Chiara,[3] Nadia Di Muzio,[3] Barbara Longobardi,[1] Paola Mangili,[1] Ivan Veronese[2a]

Radioprotection 50(3), 171-175 (2015)
© EDP Sciences 2015
DOI: 10.1051/radiopro/2015012

Application of failure mode and effect analysis to tomotherapy treatment delivery

S. Broggi[1], M.C. Cantone[2]*, A. Chiara[3], N. Di Muzio[3], B. Longobardi[1], P. Mangili[1] and I. Veronese[2]

preplanning imaging ,volume determination

Simulation, imaging and volume determination — **30 sub-processes**

- **I.** Patient identification
- **II.** Reading information on the RT record: recommended immobilization system
- **III.** Reading information on the RT record: patient position (prone-supine)
- **IV.** Reading information on the RT record: anatomical sites
- **V.** Reading information on the RT record: imaging choice
- **VI.** Definition of the positioning system (not customized system) of the patient on the CT simulator couch
- **VII.** Identification of the customized positioning system of the patient on the CT simulator couch
- **VIII.** Positioning/alignment of the patient on the CT couch on the basis of the laser
- **IX** Definition of the temporary isocenter on the basis of the anatomical site to be treated and placement of three reference markers
- **X.** Reference markers positioning to indicate previous treatment fields
- **XI.** Recall the patient identity record from the RIS system
- **XII.** Selection of the CT scan protocol
- **XIII.** Acquisition scout and scanning and CT imaging reconstruction
- **XIV.** Check of patient preparation
- **XV.** Patient tatoos in the position of the three markers at the temporary isocenter
- **XVI.** Save imaging data of the patient
- **XVII.** Sending CT data and imaging to PACS
- **XVIII.** Possible other imaging procedures (MRI, CT-PET with definition of BTV, CT with contrast medium)
- **XIX.** Placement of the RT record in the folder "Planning to be done" of the referring physician
- **XX.** Recall of the list of the CT images
- **XXI.** Recovery of the CT images from PACS to TPS
- **XXII.** Possible recovery of other images (from PACS via DICOM or tomotherapy station)
- **XXIII.** Registration of possible other images from different techniques and check of consistency
- **XXIV.** Definition of the GTVs and/or CTVs contour on the basis of the anatomical and/or functional information (BTV)
- **XXV.** Definition of ITV in the case of 4D CT scan
- **XXVI.** Automatic contour of the OAR
- **XXVII.** Manual contour of the OAR
- **XXVIII.** Definition of the planning structure at risk through automatic expansion of OAR
- **XXIX.** Automatic expansion with definition of the CTVs and PTVs margins
- **XXX.** Definition and contouring of overlapping regions

Successful simulation, imaging and volume determination

planning

Planning — **28 sub-processes**

- **XXXI.** In case of re-treatment, reconstruction of the previous treatment planning
- **XXXII.** Prescription of PTV dose (from protocol or personalized)
- **XXXIII.** Prescription of dose to overlapping regions (from protocol or personalized)
- **XXXIV.** Definition of the fractionation of PTVs: number of fractions and daily doses
- **XXXV.** Definition of specific dose limits for OAR not to be exceeded
- **XXXVI.** Placement of the RT record in the folder "Planning to be done" according to the various therapy units
- **XXXVII.** Definition of help structure regions to make easier the optimization
- **XXXVIII.** Possible contouring of the couch
- **XXXIX.** Send the contoured CT images from the Somavision/Eclipse station to the TPS of the chosen tomotherapy unit
- **XL.** If not automatically done, replacement of the CT couch (diagnostic) with Tomoterapy couch in the CT images
- **XLI.** Assignment of the contoured structures as Target and OAR
- **XLII.** Assignment of the Overlap Priority to each structure
- **XLIII.** Placement of the mobile red lasers at the tattoos, if the distance between red and green lasers is higher that a max value, then placement of red lasers in other site and notification the distance markers-red lasers to the RT technician.
- **XLIV.** Choice of the filed dimension
- **XLV.** Choice of the pitch
- **XLVI.** Choice of the CT calibration curve nCT-nHU
- **XLVII.** Choice of the Target structure for the dose prescription, and choice of the dose prescription modality
- **XLVIII.** Choice of the calculation matrix
- **XLIX.** Choice of the modulation factor
- **L.** Definition of dose-volume constraints to be associated to the Targets and to the OAR for the optimization phase
- **LI.** Choice of the weighs and penalties to be associated to the structures and to each dose-volume constraint
- **LII.** Beamlet calculation
- **LIII.** Optimization
- **LIV.** Introduction of the number of fractions and automatic generation of number of sessions
- **LV.** Video approval of planning (without this approval it is not possible to treat the patient)
- **LVI.** Treatment plan printing
- **LVII.** Video signature of the planning
- **LVIII.** QA approval

Successful planning

Tomothérapie

Préplanning imaging et détermination du volume **30 sub-processes**

38 Modes Défaillance (MD)

Planning **28 sub-processes**

36 Modes Défaillance (MD)

TOTAL 74 MD

53 MD RPN ⩽ 80

21 MD RPN >80

4 MD RPN > 125

XLII Assignment of the Overlap Priority to each structure	17	Wrong assignment	Lack of attention/ inadequate skill	Wrong dose distribution	4	7	7	196

Sur la base de l'analyse des résultats, en plus des stratégies de sécurité déjà adoptées dans la pratique clinique, de nouvelles solutions ont été proposées pour atténuer le risque de défaillances .

TABLE 3. Application of failure mode and effects analysis for the preplanning imaging and volume determination stage in tomotherapy. Failure modes having an assigned RPN > 80 are reported.

Subprocess	*No*	*Potential Failure Mode*	*Potential Causes of Failure*	*Potential Effects of Failure*	*O*	*S*	*D*	*RPN*
VIII Positioning/alignment of the patient on the CT couch on the basis of the laser	1	Wrong definition of the isocenter	Inadequate CT laser alignment	Systematic shift of the patient position	4	8	3	96
X Reference markers positioning to indicate previous treatment fields	2	Missing marker positions	Lack of attention or incomplete compilation of the RT record	Previous treatment not taken into consideration/ suboptimal planning	4	6	3	96
XXIII Registration of possible other images from different techniques and check of consistency	3	Wrong registration	Consistency not verified	Wrong PTV and OAR definition	3	7	5	105
XXIV Definition of the GTVs and/or CTVs contour on the basis of the anatomical and/or functional information (BTV)	4	Wrong CTV definition	Lack of attention/ inadequate skill	Wrong dose distribution	3	7	5	105
XXV Definition of ITV in the case of 4D CT acquisition	5	Incorrect ITV construction	Lack of attention/ inadequate skill	Wrong PTV	3	6	5	90
XXVI Automatic contour of the OAR	6	Missing OAR definition	Lack of attention/ inadequate skill	Unintended normal tissue irradiation	3	8	5	120
XXVII Manual contour of the OAR	7	Missing OAR definition	Lack of attention/ inadequate skill	Unintended normal tissue irradiation	3	8	5	120
XXVIII Definition of the planning structure at risk through automatic expansion of OAR	8	Wrong expansion	Lack of attention/ inadequate skill	Unintended normal tissue irradiation	3	5	6	96
XXIX Automatic expansion with definition of the CTVs and PTVs margins	9	Wrong expansion	Lack of attention/ inadequate skill	Unintended normal tissue irradiation	3	5	6	96
XXX Definition and contouring of overlapping regions	10	Wrong/missed definition	Lack of attention/ inadequate skill or not detailed information on previous treatment	Unintended normal tissue irradiation or wrong dose distribution	4	7	5	140

M.C. Cantone, AFRP 2016

Conclusion

AMDE en pratique s'est révélé un instrument utile pour l'évaluation proactive de la sécurité du patient dans les techniques modernes de radiothérapie. L'application de cette méthode consent d'identifier des stratégies pour réduire le risque en plus des mesures de sécurité déjà adoptées dans la pratique clinique.

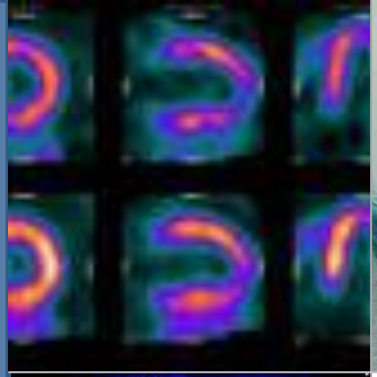
L'expérience a clairement montré que durant **l'identification des causes des défaillances** et l'estimation de la probabilité qu'ils se vérifient, la compétence et l'expérience des différents professionnels impliqués dans le RT, tout comme leur environnement de travail, sont importants tant du point de vue de la **qualité du traitement que pour la sécurité du patient.**

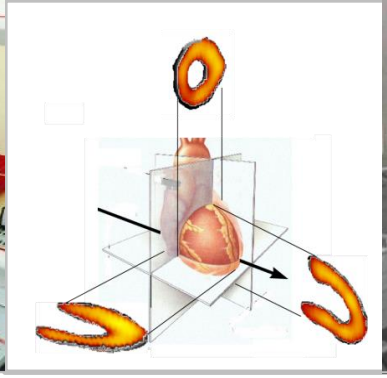
La Culture de la Radioprotection en RT

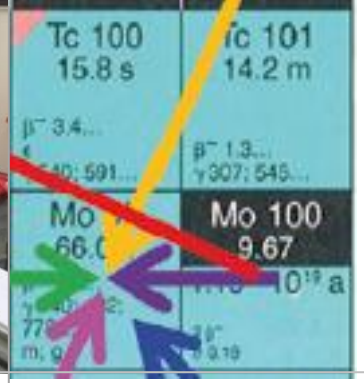
peut aussi être vue comme:

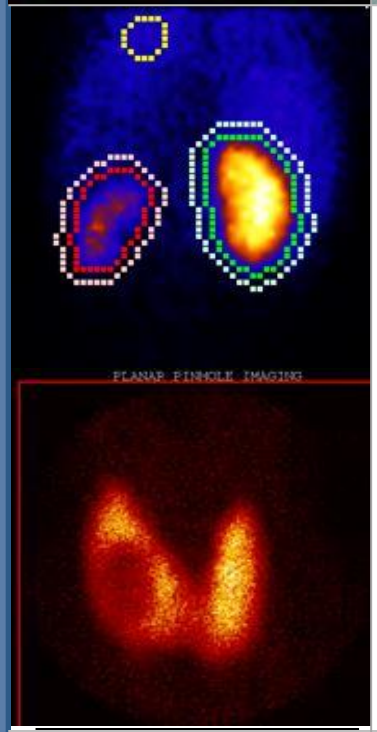
*“Radiation therapy should be performed with a full understanding of the process, due thought, mindfulness, alertness, and a **clear sense of accountability**.”*
(ICRP 112)

L'expérience démontre que **AMDE**, fournit les efforts du personnel nécessaires, est réalisable et conduit à de nouvelles solutions pour atténuer le risque de défaillances, **d'augmenter la sécurité des patients.**









Merci pour votre attention

