NACMPA
North American Chinese Medical Physicists Association

North American Chinese Medical Physicists Association

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NACMPA NEWSLETTER

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President's Corner……

I wrote this note on the morning of Thanksgiving Day. I want to express my appreciation for you, our members of NACMPA. I appreciate your support and your participation. A special greeting goes to NACMPA board members and officers, who have been working hard to strengthen our organization. I have enjoyed reading every issue of NACMPA WeChat （北美华人物理师公众号）； thanks for the great effort from Dr. Chengyu Shi, our board member in large. Thanks for the participation of NACMPA members, the NACMPA Symposium at the annual meeting of the Physics Group of Chinese Society of Radiation Oncology in Chongqing, China, on October 26-28, 2017, was a huge success. The meeting provided a platform for NACMPA members to enhance their communications, collaborations and friendship with medical physicists in China. I appreciate the opportunity to work with all of you. Together we are making a much stronger organization. In this holiday season, I wish you and your loved ones happy holidays, a season full of joy and cheer!

X. Allen Li, Ph.D., FAAPM
NACMPA President

Congratulations to Dr. Fang-Fang Yin and Dr. Jing Cai……

Dr. Fang-Fang Yin被评为2017年ASTRO Fellow！这是华人物理师在ASTRO能够得到的很高荣誉。ASTRO Fellow是2006年开始设立的，评审需要现有的Fellow提名，并且至少为ASTRO服务15年，其中10年在研究，教育，病人服务或者领导才能方面有重要贡献。

红皮期刊, RED JOURNAL, 是放疗领域的顶级期刊之一。其审稿人水平要求很高，并且需要能够提出很有建设性的评审意见。每年都会评一些顶级审稿人称号。Dr. 蔡璟 (Jing Cai)教授荣获2016顶级审稿人称号，这是华人物理师在研究领域的又一成就。

Seeking Contributors

NACMPA NEWSLETTER is published by the North American Chinese Medical Physicists Association on a semiannually schedule. We welcome all readers to send us any suggestions or comments on any of the articles or new features to make this a more effective and engaging publication and to enhance the overall readership experience. Next issue: June 2018.

Contact us: nacmpa@yahoo.com 欢迎大家投稿,并希望大家关注北美华人物理师公众号.

Editors: Zhigang (Josh) Xu, Ph.D. , Chao Guo, M.S.

NACMPA 23rd Annual Meeting hosted on Aug 2, 2017, Denver, CO

每年一届的北美华人物理师协会于2017年8月2日晚在美国丹佛Empress Seafood Restaurant 举行。大约300多人参加了此次盛会(图1)。会议表彰了Jackie Wu (上届主席) 和Pengpeng Zhang (上届秘书) 对北美 华人物理师协会所做出的贡献。 徐志岗作为 下届 主席给Pengpeng Zhang 颁奖 (图2)。大会也颁发 了北美华人物理师协会相关的期刊IJMPCERO Journal (http://www.scirp.org/journal/ijmpcero/) 最佳文章奖项: “Clinicopathological and Prognostic Significance of Circulating Tumor Cells in Patients with Head and Neck Cancer: A Meta-Analysis”, Vol. 5(2), 2016. Dr. Lei Xing 作为该杂志主编颁奖 (图3) 。 大会同时 选举了 Fang-Fang Yin教授作为名人堂Hall of Fame 2017获奖者, 现任主席Allen Li进行颁奖 (图4)。 Fang-Fang Yin做了精彩的演讲 (图5)。现任主席Allen Li 回顾了今年协会发展状况和对未来的展望，特别欢迎大家参加十月重庆会议 (图6) 。 现任财务曹明进行了协会情况报告(图7)。大会还进行了秘书和member-at-large选举。共有四个 候 选 人。秘书人选: Taoran Li和Dengsong Zhu， member-at-large人选 ：Lei Ren和Chengyu Shi。最后经过 公开 公正公平的选举，Dengsong Zhu当选下届秘书， Chengyu Shi当选下届member-at-large。会议在友 好的气氛中结束。感谢组委会，尤其是现任秘书Jing Cai的主持和协调工作， 同时感谢 当地组织者周鹏 和Duke大学很多志愿者的工作。本次会议还有很多新的议题，我们将陆续报道。敬请关注北美华人物理师公众号。


图1


图2

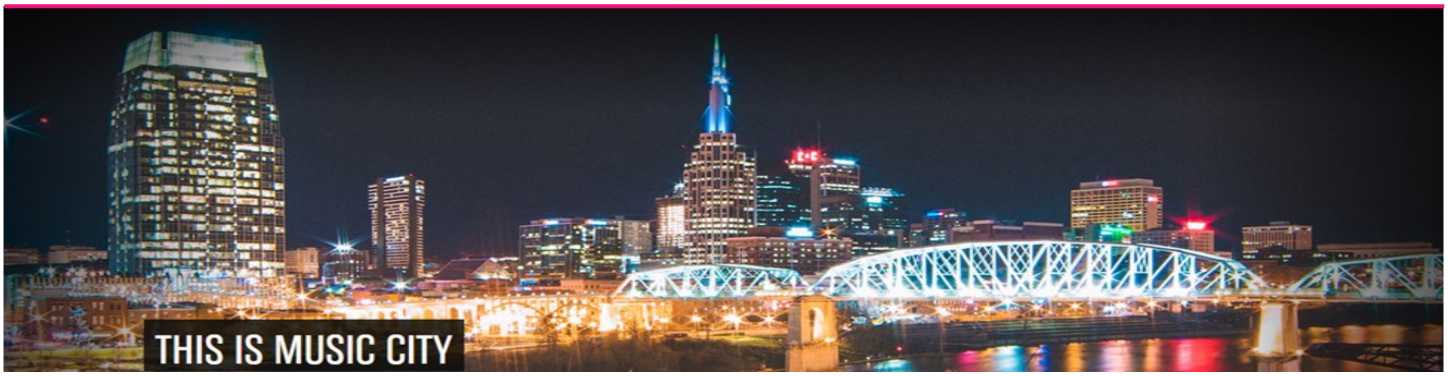

图3


图4

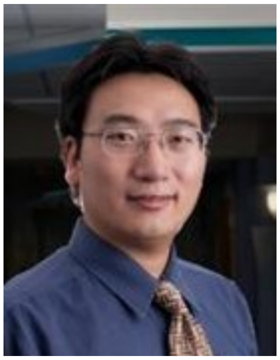

图5


图6


图7



2018 AAPM Annual Meeting (Nashville TN • July 29 - August 2)



Dengsong Zhu, M.S.
NACMPA Secretary

Nashville是田纳西州首府，田纳西州中部最大的城市，被誉为“乡村音乐之都”，距离西部的Memphis和东部的Knoxville各为3个小时的车程。

1. 音乐街：Nashville 的灵魂
音乐街位于Nashville市中心，环绕着音乐广场一周，称得上是美国音乐业心脏与灵魂的所在。对于乡村音乐发烧友，这里有乡村音乐名人堂，展示纪念品和乐器，纪念各位乡村音乐大神。在百老汇街上有大大小小酒吧，每天从早到晚有乐手驻唱，其中Konktonk Row经常有着明日之星以及在排行榜名列前茅的歌手。

2. Nashville 帕台农神庙
在距市中心不远的世纪公园，座落着“山寨”的雅典帕台农神庙。神庙始建于1897年，木质结构，为了纪念田纳西州建立一百年，后来在原址用水泥重建，是与希腊神庙原型丝毫不差的复制品。庙内保存着19世纪和20世纪美国画家的63副画作，还有一座高达42英尺、以金叶子覆盖全身的雅典娜女神像。

3. The Grand Ole Opry
Grand Ole Opry包括 General Jackson游船，Gaylord Opryland 度假会议中心，以及Opry Mills购物中心。General Jackson是一艘四层桨轮游船，行驶在Cumberland河上，游客可以一边吃饭一边看节目。游客还可以到Ole Opry House看秀，并且可以参观后台。Gaylord Opryland 度假会议中心四季如春，里面有着各种热带植物，赏心悦目。

4. Cheekwood 植物园和艺术博物馆
Cheekwood以其漂亮的花园和公园般的格局闻名。其中有四个山茶花和兰花的温室，一个现代艺术馆，还有位于一座建于上世纪20年代的佐治亚风格豪宅内的艺术博物馆，展示19世纪和20世纪的艺术收藏品。

5. Hermitage 总统故居
Hermitage是一个1120英亩的历史胜地，曾经是美国前总统安德鲁·杰克逊的住所。这是全美保存得最好的美国早期总统故居之一，里面有一座博物馆，还展示了早期的日常起居生活。

6. Smokey Mountain
Smokey Mountain国家公园距离Nashville3个多小时车程，是美国每年游客最多的国家公园，也是美国东部黑熊数量最多的地区。

7. Kentucky Mammoth Cave
Kentucky Mammoth Cave国家公园位于肯塔基州中部，距离Nashville一个半小时左右车程，有着世界上最长的洞穴。

8. 关于吃饭
Stoney River：比较高档的牛排店，Nashville最好的牛排店之一，相当美味可口，人均$31-$50。Aquarium Restaurant：与水族馆融于一体的海鲜饭店，吃饭时可以一边欣赏100多种五颜六色的热带鱼在身边游来游去，还可以看到潜水员喂鱼，对于大人小孩来说都非常有趣。Asian Corner Café/Bistro：Nashville最好的中餐馆，四川风味，有两家分店，其中新店环境比较好。

Excellent Community Contribution Award Coming in 2018

Yu Chen 陈昱 1973 - 2017

Chinese physicists accounted for a sizable proportion of the Medical Physics Community in North America. This team is getting bigger and ever more coherent, with every one of us benefiting from the networking of this community. The continuing success of the community would not be possible without the service and contribution of many volunteers. To our community more coherent and prosperous and our voices stronger in North America and around the world, the service and contribution from even more volunteers will be needed. Starting in 2018, Yu Chen Award of Excellent Community Contribution will be awarded annually to one medical physicist selected by the Chinese medical physics community for making stellar contribution in terms of service and volunteering for the community. The award will include a recognition plaque and a small cash prize of a few hundred dollars, as a small gesture to recognize and appreciate the generous contribution of time, talents, and efforts of the awardee to the entire community. The award is sponsored by the Yu Chen Memorial Fund (YCMF), set up by friends and family in the loving memory of Medical Physicist, Yu Chen, who passed away in 2017. For people who knew him, Yu was a man of many extraordinary qualities, one of which was the spirit of service and volunteering. Indeed, when a motor boat abruptly claimed his life on Lake Mendota, Madison, WI, Yu was still working as a volunteer windsurfing instructor in his 6th year on this post generously contributing his time and talent for other people's learning. For the volunteers, they do not volunteer in order to be recognized, but because they view it as the right cause and they enjoy. However, it is the hope of the YCMF in initiating this annual award, to appreciate these volunteers' contributions and to encourage more people to volunteer and serve for an even better future of the Chinese medical physics community. Each year, the winner of this award will be announced at the NACMPA annual gala.

Yu Chen Memorial Fund, Inc.

中国生物医学工程学会医学物理分会 Chinese Society of Medical Physics

郭学玲 物理师

上海长海医院放疗科

中国生物医学工程学会医学物理学分会正式成立于1981年。后经中国科协的批准，分会以“中国医学物理学会”的名义，代表我国医学物理学界先后加入国际医学物理组织（IOMP）和亚太医学物理联合会 AFOMP）。

经过30多年的发展，医学物理分会会员人数由最初的数十人增长到现在的近千人。会员分布于全国医疗单位中的物理师群体、高等院校、科研院所、厂矿等单位，主要从事临床、科研和教学工作，为中国的医疗卫生事业做出了突出贡献。胡逸民教授作为首席物理师代表，从1998年至2017年担任医学物理学分会主任委员，曾获得国际医学物理组织(IOMP)全球卓越医学物理学家殊荣，并获得全球仅有6人的IOMP Fellow荣誉称号。2017年3月成立第八届委员会，首都医科大学生工学院刘志成教授为现任主任委员。目前分会设八个专业委员会，分别是医学放射物理专业委员会、医学影像物理专业委员会、医学生物物理专业委员会、生物医学信号物理专业委员会、临床血液流变物理学专业委员会、核医学物理专委会、医学物理教育专业委员会和辐射防护专业委员会。

医学物理分会下属的各专业委员会也经常组织各种各样的学术活动和科普宣传活动。积极开展国际学术交流活动，加强同国外的学术团体和同行科技工作者的友好联系，先后与IOMP、SFMP(法国医院物理师协会)、AAPM（美国医学物理学家协会）、AFOMP（亚太地区医学物理组织联合会）等医学物理学术团体召开国际学术会议。

医学物理分会一般每两年召开一次学术年会，2015年10月5日至8日，在西安成功举办2015亚太地区医学物理大会（AOCMP）。此次大会是国际性的学术交流大会，共有300多名国内外专家学者前来参加大会，会议共收录论文200多篇，内容详实包括放射治疗、影像技术、核医学、辐射防护、新技术等内容，大家讨论热烈，对中国医学物理的发展起到了推动作用。2017年11月4日至5日《2017 IEEE国际医学影像物理和工程大会暨第八届中国医学影像物理学术年会》在北京召开。由北京、天津、河北、山东、山西、河南、内蒙古组成的《京津冀+放射物理专业组》学术活动已成功举办了28次，为医院的物理师提供了学术交流平台，受益匪浅。中国医学物理分会官方网址：http://csmp.org.cn/news/news/index.htm。

主要刊物及主编

中国医学物理学杂志，主编胡逸民。创办于1983年，是第一军医大学主管的国家重点学术期刊，CSCD核心期刊，影响因子0.483，现被CSCD 中国科学引文数据库来源期刊(含扩展版)等权威机构收录，主要征稿方向：放射物理学、医学影像物理、激光医学、医学信号处理等。

目前在中国医院放疗科工作的物理师参加的主要学术组织还有，中华医学会放射肿瘤治疗学分会《放射物理专业学组》。该学组成立于1986年10月，首任组长为胡逸民教授，第二任组长由张红志教授担任、现任组长为邓小武教授。该学组每年主办一次学术年会“全国放射肿瘤物理学年会”。 2016、2017年年会分别在哈尔滨市、和重庆市召开，2018年年会拟在福建福州召开。参会人数每年增多，2017年参会代表约1000人。每年年会同时会组织论文征稿，如2017年年会的征稿主题为“放射肿瘤物理学实践与研究；肿瘤放射治疗新技术及规范；立体定向放疗技术学进展”，进行优秀论文评选，并发表论文集，方便同行进行学术沟通交流。

中华医学会放射肿瘤治疗学分会 (CSTRO)
http://www.cstro.cn/fenhui/jieshao/2017-05-28/48.html

北美华人物理师微信公众号

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Chengyu Shi, Ph.D.
NACMPA
Board member-at-large

2017年8月9日，这是一个对于北美华人物理师协会有纪念意义的一天，这一天我们以协会名义发了第一篇微信公众号文章《相约重庆，我们用奖金支持你》。时间再提前7天，即2017年8月2日晚上，北美华人物理师协会进行了新一轮选举，我幸运地得到大家的支持，被选举为member-at-large。这是大家对我个人的信任和认可，我也表达了为大家服务的意愿。8月2日晚，我们新老协会主要成员讨论了利用微信来更好地沟通会员，并计划开通一个公众号来宣传协会，搭建协会同会员之间沟通的桥梁的问题。同时利用已经有的 “物理狮”群，来及时同大家进行交流。我个人被赋予开通公众号的神圣任务，感觉压力和责任很重大。毕竟对于我来说，这是一个新课题。

说干就干，这是我的风格。通过调研，微信公众号申请比较简单，但是对于组织，必须是中国政府注册的。我们协会是美国注册的，很不方便开组织公众号。好在我们还可以开个人公众号，王保东博士利用自己的资源奉献了一个个人公众号，作为组织的公众号。虽然有很多限制，但是有胜于无，毕竟是个好的开端。

公众号有了，那么我们发些什么信息呢？当然可以发协会的通知消息等，可是这样太单薄了，也不是很活跃。我个人就建议发会员介绍，发学术文章沟通，发会议摘要，发与物理师相关的任何信息，必要时候也可以为了活跃气氛发些消遣的文章。就这样，公众号开通并运行了。到目前为之，共有1829人关注公众号，发了86条图文消息。从最开始的无所适从，到现在比较淡定了，我们一步步走向了成熟。成熟的另外一个标识就是获得微信的认可，开通了很多其它功能。这里特别感谢贡献了个人研究成果的物理师们：Allen Li, 王石，Charlie Ma，王保东，殷芳芳，董雷，胡逸民，Clifton Ling, 萧安成, 蔡璟, 严玉龙, 王京, 邓军，曹旻松，Maria Chan，杨英立，吴宾宾，李光，王东旭，唐晓莉，Weili Zheng，陈小明，Huixiao Chen，桂大为，曹达亮，Quan Chen，Weixing Cai，温宁，徐志岗。

一个新生的事物，毕竟需要大家共同的关怀和支持。北美华人物理师协会的公众号不是某个人的，也不是协会主席团的，是所有会员的公众号。只有所有会员参与，奉献并关注了，这个公众号才能发挥它最大的功用。所以，欢迎大家投稿NACMPA@yahoo.com。并希望大家关注北美华人物理师公众号，我们将竭诚为大家服务!

Deciphering Big Data in Radiation Oncology and Beyond

We are at a historic moment in medicine. On one hand, there are massive quantities of data generated every moment by the patients in the clinic and populations around the world. It is estimated that over 90% of all the data in the world was created in the past 2 years, and every 2 days we created as much information as we did from the beginning of time until 2003. On the other hand, the scientific development in artificial intelligence (AI) and technological advancement in graphics processing units (GPU) have shown great promise in tackling big health data to individualize treatment, improve patient care, and reduce cost. Nowadays, we can perform a comprehensive 'omic' assessment of an individual, including one's DNA and RNA sequence and characterization of one's proteome, metabolome and microbiome. **These individual data set up a remarkable and unprecedented opportunity to improve medical treatment and develop preventive strategies to preserve health.**

Big data in radiation oncology

In modern radiation oncology, big data generally consist of patient demographics stored in the electronic medical record (EMR) system, beam settings, plan parameters and dose volumetric information of the tumors and normal tissues generated by treatment planning system, 3D and 4D anatomical and functional information from diagnostic and therapeutic imaging modalities stored in the picture archiving and communication system (PACS), as well as genomics, proteomics and metabolomics information derived from blood and tissue specimens. Currently these data are largely exploited in the applications such as knowledge-based treatment planning, radiomics, auto-contouring, and treatment outcome prediction.

With NIH R01 support, we have focused our research on (1) organ dose tracking for patient safety and (2) early cancer detection via machine learning and deep learning with medical and non-medical data sets.

Tracking organ doses for patient safety in radiation therapy

In this project, we propose to build a personal organ dose archive (PODA) to track and accumulate each patient's organ doses associated with the use of sophisticated treatment technologies and image-guidance procedures in modern radiotherapy. With PODA deployed in routine clinical practice, radiation harm can be effectively avoided with early warnings and radiation treatments can be better guided with comprehensive knowledge of organ dose accumulations in 3D. The ultimate benefit of PODA is to improve patient safety and reduce side effects for millions of cancer patients undergoing radiotherapy every year.

Jun Deng, Ph.D., FAAPM, FInstP
NACMPA Member

Basically, PODA compiles and consolidates all the valuable personal organ dose data into one single archive, data that is often scattered around at various institutions and various EMR databases, and is often forgotten over a long time. The strength of PODA stems from the fact that it is designed to accumulate personal organ dose data along one's lifetime accurately (Monte Carlo dose simulation), comprehensively (all ionizing radiation and all relevant organs), and quantitatively (absolute dose distributions in 3D). The PODA built for each individual patient is a permanent and accurate replica of one's journey through time and space, in a dosimetric way. Its power will show up when data pooling and sharing is needed in the clinic to draw any meaningful conclusions with statistical power and certainty. Data sharing and pooling will become very convenient and highly efficient in the era of big data, largely reducing the potential errors due to lack of data or data loss and helping the clinicians make informed decisions in the clinic.

Besides a direct impact on cancer patients receiving radiotherapy, PODA can also be very useful in other fields where ionizing radiation plays a role, e.g., CT, PET and fluoroscopy used in diagnostic imaging. Accurate and comprehensive organ dose tracking would be very necessary in order to protect people from normal tissue damage and reduce second cancer risks in tens of millions of people receiving CT and other radiological procedures worldwide. This is especially critical for children who are more vulnerable to radiation damage than adults.

As we move into an era of big data, cloud computing and personalized medicine, we are very excited about the potential use of PODA. For example, one possible application can be that all personal organ dose information may be stored securely in a cloud computing database for easy access anytime anywhere. Another viable scenario could be that every patient can access and download a copy of one's own personal organ dose archive in a portable device such as a USB drive or a wearable device such as an Apple Watch or a Fitbit for ultra-portability.

Deciphering personal health data for early cancer detection

Cancer is a serious public health issue with an estimated 21.7 million new cases and 13 million cancer deaths over the world by 2030. Although a tremendous amount of money and resources have been spent on cancer care over the past 50 years, the cancer mortality rates worldwide are still high in some parts of the world. One of the major reasons for high cancer mortality rates is the failure to diagnose cancers at early stages, missing perhaps the best window of opportunity for intervention. It is therefore highly impactful and clinically significant if we can detect and manage cancers as early as possible and perhaps even prevent them prior to their onset.

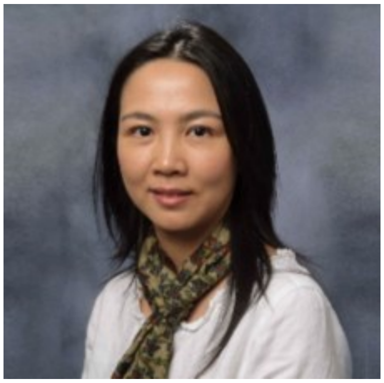
Currently there have been several major initiatives targeting on smart digital health. Amazon has recently started a secret project coded '1492', dedicated to building a platform for virtual doctor consultations and making EMR available to the consumers and the physicians. Google/Verily Life Sciences has also initiated the 'Project Baseline' in order to develop a well-defined reference of good health as well as a rich data platform to better understand the health-disease transition and disease risk factors.

Recently we have developed and evaluated a series of deep neural networks (DNN) for cancer prediction based solely on personal health data extracted from the National Health Interview Survey (NHIS) datasets. Built upon these encouraging results, we are developing an individualized cancer risk management tool for early cancer detection and prevention based solely on personal health informatics such as age, gender, race, body mass index, diabetic status, smoking status, drinking habit, chronic obstructive pulmonary disease, asthma, hypertension, heart diseases, physical exercise habits, and history of strokes etc. With this tool, individual cancer risks can be stratified and monitored based on one's health data and real-time updates for early detection and effective prevention. As the required personal health data is commonly available, our tool will be easy to implement, cost-effective and non-invasive. By circumventing the existing EMR and using a global open data network, we will be harvesting new big data from contributions around the world, hence avoiding a big roadblock in terms of data access. A global tracking and a sustainable data ecosystem will significantly contribute to effective cancer detection for millions of people, thereby helping reduce cancer mortality worldwide in the long term. Looking forward, with proper adaption of smart deep learning algorithms and comprehensive data amalgamation, a holistic monitoring, modeling and understanding of human health may be achieved and used to manage not only cancer risks but also risks for other major diseases such as diabetes, strokes, and heart disease.

In the not so distant future, a systematic approach to the multifaceted individual data aided with artificial intelligence may usher in a new age and eventually transform our current evidence-based medicine into a predictive, preventive, personalized and patient-driven medicine, totally revolutionizing our health care.

Group members from Yale <u>(from left to right):</u>
Gregory Hart, Ph.D., Postdoc Fellow
Ying Liang, Ph.D., Postdoc Fellow
Issa Ali, B.S., Graduate Student
Jun Deng, Ph.D., DABR, FAAPM, FInstP
Bradley Nartowt, Ph.D., Postdoc Fellow
Wazir Muhammad, Ph.D., Associate Research Scientist

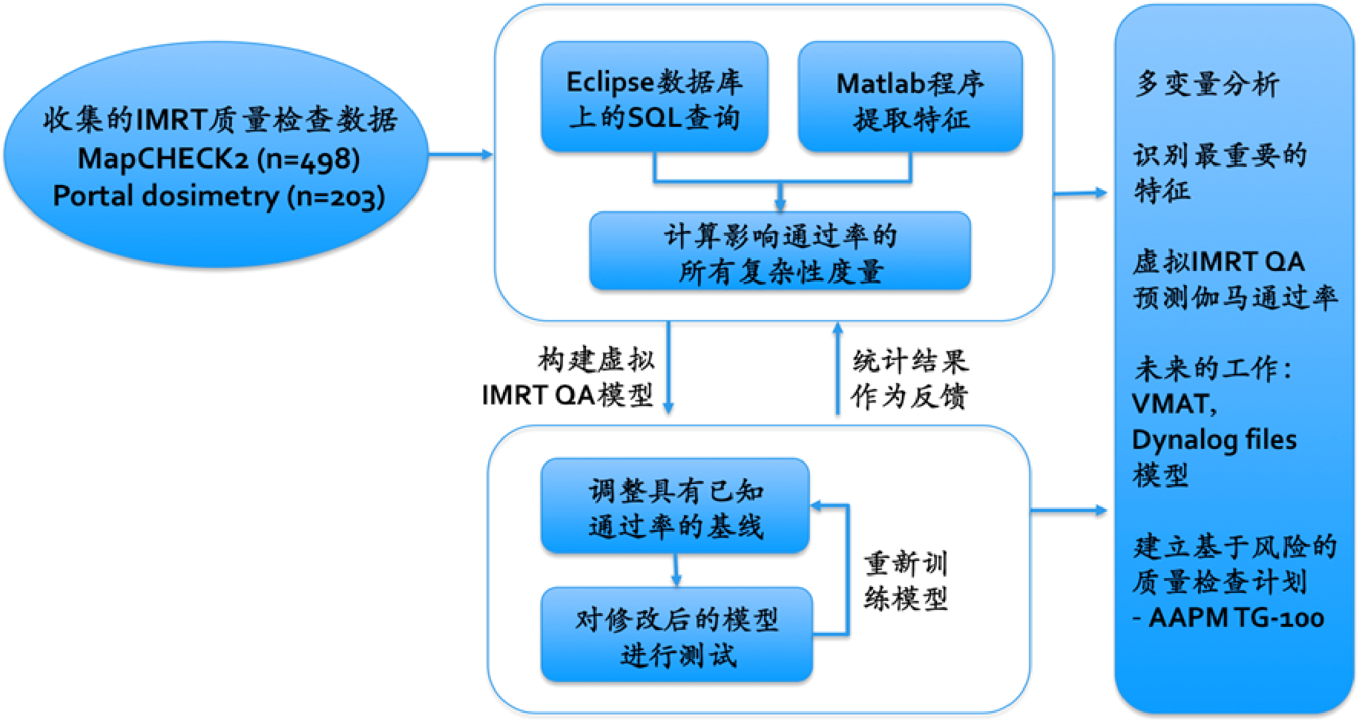
人工智能（机器学习）与放疗质量保证的研究



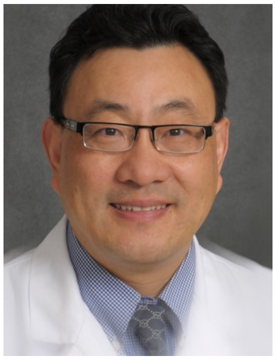
Maria F. Chan, Ph.D.，FAAPM
Past-President & Board Member,
NACMPA

放射治疗是一个日益复杂的过程。机器学习是数据科学的一个子领域，侧重于设计可以学习和预测数据的算法。机器学习在放射治疗中的应用近年来逐渐出现，其应用包括辐射肿瘤学治疗结果的预测建模，治疗优化,错误检测和预防, 以及治疗机质量 保证(QA)。这些机器学习技术为医生和物理学家提供了更有效和准确的治疗方法以及实现个性化治疗的能力。 最近，机器学习已经在放射治疗的临床剂量学领域被探索 。在调强放疗之前进行特定患者的治疗前验证是很常见的。这个过程是耗时的，并不是完全有启发性的，因为无数来源会影响合格的结果。机器学习算法（例如Virtual IMRT QA）通过监管学习（Supervised Learning) 在Eclipse 调强波束特征提取(每个计划都提取了90个特征)可以预测IMRT QA通过率，并找出其他不明显的错误来源。该算法已经通过Poisson regression with Lasso regularization训练调强计划特征和每个通过率之间的关系。并使用不同的QA测量设备（二极管阵列检测器和门户剂量测定）确定了调强放疗计划复杂度指标与伽马通过率之间的相关性。在宾夕法尼亚大学和纪念斯隆凯特琳癌症中心不同机型（TrueBeam and Trilogy Linacs)的大型异构数据集进行验证。图1说明了多机构验证的工作流程。

全新模型需求至少200个训练数据集，调整模型只需80以上。确定容易出现质量保证失败的计划，可以使物理学家集中资源开发积极主动的质量保证方法，并提供AAPM TG-100中描述的策略性改善病人护理工作流程所需的错误来源信息。IMRT中的机器学习QA提供了一个框架，可以建立通用的标准和阈值，相互比较的结果，安全有效地实施适应性放，从长远角度来说，完全消除失败的QA。这代表了QA执行方式的基本范式变化。



Secure EMR Sharing Using Blockchain



Zhigang (Josh) Xu, Ph.D.
NACMPA President-Elect

Electronic Medical Records (EMRs) are critical information for diagnosis and treatment in radiation therapy, which need to be frequently distributed and shared among peers such as healthcare providers, insurance companies, pharmacies, researchers, patient families, among others. EMR data are highly private and sensitive, which poses major challenges for current healthcare data sharing infrastructures. Current sharing of EMR data is often a tedious manual process with consent form, record printing, and faxing or mailing. Such process has a significant turnaround time and could lead to waste of healthcare resources due to re-examinations without prompt data sharing, and potentially delay the treatment of urgent patients. There is also lack of control of EMR data once such data are shared. While health information exchange (HIE) based networks provide sharing infrastructures for electronic healthcare information across organizations, they come with their own limitations. Critical issues of data privacy, security, efficiency, access control and audit trails of data sharing remain challenges for EMR data sharing among organizations.

Recently, blockchain technologies emerge with tremendous momentum with the success of Bitcoin crypto-currency. Blockchain uses distributed ledger to provide a shared, immutable, and transparent history of all the actions that have happened to all the participants of the network. It enables a new generation of transactional applications that establish trust, accountability and transparency. Blockchain makes it possible to have complete control of data and privacy without a central point of control, thus highly cost-efficient for building applications for sharing data. Adopting blockchain infrastructure with immutable and transparent ledger to EMR will help manage authentication, confidentiality, accountability for EMR data sharing with a highly innovate, secure and trustable methodology. This will allow medical practitioners and researchers for fast and secure data access to improve medical treatment and advance clinical research with much reduced cost and significant improvement of efficiency – potentially revolutionizing the healthcare data sharing infrastructure.

Our goal of this project is to bridge the gap between blockchain technologies and EMR data sharing by researching the critical technology components and developing and testing a general EMR data sharing framework using blockchain. Specifically, we will develop critical components for an blockchain based EMR data sharing network, consisting of blockchain network architecture, data management and access control, transaction workflow management, security architecture, and audit trails. We will implement a prototype system on sharing EMR records for patients that are receiving cancer treatment via ionizing radiation, and provide a pilot study across multiple distributed US healthcare providers to testify the system. This will provide an exemplar testbed to build next generation EMR sharing infrastructures for the communities. If you are interested in this project, you can contact Dr. Xu @: Zhigang.xu@sbumed.org

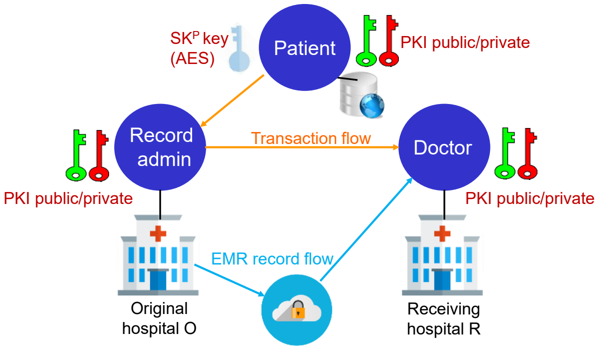


Figure 1: EMR data sharing workflow and security architecture.

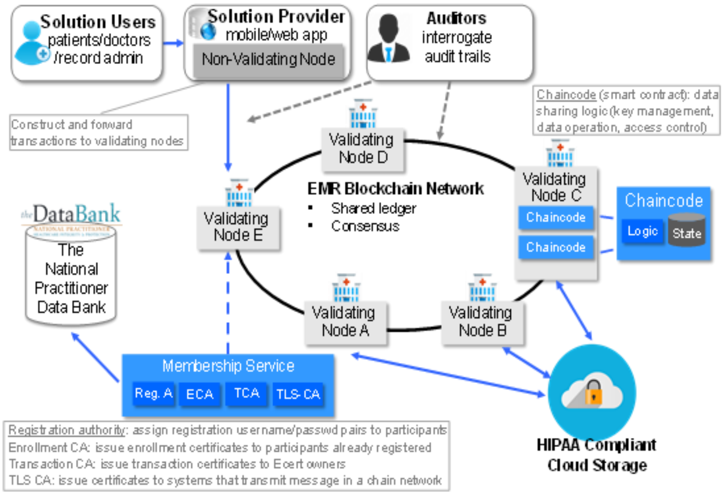


Figure 2: EMR Blockchain Architecture for Radiation Oncology

4π Radiotherapy: Past, Present and Future

Past

Radiotherapy has been heavily driven by technological advances. Clinical needs, new hardware capabilities and software innovations often trigger one another, leading to emerging major radiotherapy technological breakthroughs including intensity modulated radiotherapy (IMRT), image guided radiotherapy and particle therapy that profoundly changed the radiation oncology clinical practice and outcome. Sometimes, technology innovations take a steady pace. MR guided surgical intervention was first implemented in the early 90s, followed by MR guided brachytherapy and MR guided thermal ablation. MR guided external beam radiotherapy was certainly postulated earlier but viable ways to implement such idea took longer to materialize. Slowly but surely, MR guided external beam radiation therapy has entered the clinical domain and started to influence our practice. In other cases, the path to fruition is slightly more tortuous. A good example is inverse optimization for treatment planning, which was initially proposed by Andre Brahme to deliver uniform dose and avoid the dose drop-off at the edge of the target. However, despite being a revolutionary idea at the time, there was no easy way to intensity modulate the X-ray fluence and the idea went quiescent for almost a decade, until binary MLC was invented as part of MIMic. IMRT has since taken off in various shapes and colors. Today, IMRT is bread and butter of radiotherapy and people tend to forget what an ordeal it was just two decades ago to deliver such treatment.

Non-coplanar radiotherapy is no exception. The idea of using many beams from many angles to treat the tumor probably predated the inception of GammaKnife but made major its clinical impact with GammaKnife. The advantage of using non-coplanar beams vs. fewer beams or coplanar beams seemed so evident that rigorous dosimetry comparison was not performed until 80s, when authors like Ervin Podgorsak showed unambiguous dosimetric benefits using non-coplanar beams vs. coplanar beams for intracranial stereotactic radiosurgery (SRS). With the established efficacy of utilizing non-coplanar beams in intracranial SRS, there has always been an interest to introduce similar treatment for extracranial targets. In various dosimetric comparison studies, non-coplanar plans using manually selected beams were compared with coplanar plans for extracranial sites. The results have been mixed with some showing a dosimetric advantage some not. The enthusiasm for general applications of non-coplanar therapy was further dampened by difficulties in treatment planning and delivery. In practice, non-coplanar beams were added on an ad hoc basis that can often instigate a minor protest from the therapists when more than a couple of such beams are used. After all, their dosimetric benefit for extracranial treatment was unclear and if anything, they appeared to be more disruptive than essential.

Ke Sheng, Ph.D.
NACMPA Member

While the clinic and hardware may not be ready, researchers working on theoretical problems and computer simulation were fascinated by the non-coplanar planning problem, particularly the beam orientation optimization problem. One can easily formulate the non-coplanar beam selection problem as a combinatorial problem, which when the candidate beam number is sufficiently large becomes unsolvable with too many possible combinations. The number of possibilities to select 10 beams out of 1000 equally spaced non-coplanar beams is 2.63E+23 without accounting for the possible intensity modulation of each beam! Due to the lack of a tractable mathematical solution, physics intuition had to kick in. Intuitively, beams that minimally penetrating critical organs were better than beams penetrating a lot of critical organ volumes. The volumes of overlap with these critical organs can be easily calculated and then the beams ranked accordingly. The limitation of this approach was evident, clean beams that do not penetrate any critical organs are rare. Some of the target dose had to be delivered with primary beams going through critical organs but the overlapping volumes cannot be readily used for dosimetric trade off: how can we choose between a beam with 1 cc of spinal cord overlap and another beam with 4 cc parotid overlap? Clearly, geometrical endpoints were insufficient and dosimetric values had to be included. At the time, analytical methods were unavailable to solve dosimetric problems of this scale, stochastic methods such as genetic search and particle swarm were used to chisel away the colossal computational problem. These methods were able to solve simple cases or find acceptable solution for complex cases but overall uncompetitive in dosimetry or planning time. A viable analytical solution was still needed.

Present

Benefit from operations researchers like Edwin Romeijn, the seemingly unsolvable beam orientation optimization problem found a possible solution using column generation, which starts by solving a small and manageable problem, such as if one beam has to be picked out of the one thousand beams, what would it be? The solution of the small initial problem would provide a direction to add the next beam. On the surface, the method appears to be ad hoc with uncertain optimality. However, the greedy approach is backed by a mathematical theorem known as the Karush–Kuhn–Tucker (KKT) conditions to approach optimality for nonlinear optimization problem as long as certain regularization conditions are satisfied. Without getting into too much detail, suffice to say, the beam orientation and fluence map optimization problem can be written into a form that meets these conditions. With precomputed beamlets, the large scale non-coplanar optimization problem was solved for the first time, showing remarkable dosimetric advantages for cases including the lung, liver, head and neck, prostate, brain, vertebrate and pancreatic cancers. The term 4π radiotherapy was coined at the same time due to extensive involvement of the 4π spherical steradian angles, as opposed to the "2π" coplanar treatment on a circular trajectory. The remarkable dosimetric improvement was mainly from the improved dose compactness often measured by R50, the ratio between 50% isodose volume and the planning target volumes. For experienced dosimetrists who remember the early days of implementing lung stereotactic body radiotherapy (SBRT) following the RTOG 0236 protocol, R50 was almost impossible to meet. Other than the lack of dose inhomogeneity correction in generating the metric, Dr. Robert Timmerman was known to use many non-coplanar beams to make the dose as compact as possible. Compared with the previous manual studies with equivocal conclusions, the dosimetric improvement using this new 4π planning tool is definitive due both to the algorithm's capability of searching the vast solution space and the more quantitative representation of feasible beams based on optical modeling.

Increasing the number of non-coplanar beams pushes the very low dose to a larger volume in exchange for the markedly reduced high dose spillage, which is associated with acute and severe toxicities. Extensive use of non-coplanar beams thus has raised a concern over the integral dose and increased normal tissue volumes exposing to radiation. The answer is slightly counterintuitive: 4π radiotherapy actually maintains similar integral dose compared with coplanar arc therapy according to a study by Nguyen et al. Although normal tissue volume receiving low dose is increased, for patients with aggressive diseases that tumor control and reduction of acute toxicity are prioritized, the tradeoff is worthy.

When it comes to the delivery of 4π radiotherapy, there is another story. The most widely available linacs with C-arm gantry are, paradoxically, designed to be both capable of delivering non-coplanar beams and cumbersome at doing so. Since the gantry only has one degree of freedom, extensive couch rotations are needed to be combined with the gantry rotation for non-coplanar beam angles, creating a complicated clearance issue. One could create a non-coplanar beam angle, or a gantry/couch maneuvering trajectory that causes collision. In the former scenario, the plan needs to be revised and the treatment delayed. To avoid the latter scenario, the therapist has to enter the room and manually perform couch and gantry maneuvering, resulting in impractically long treatment sessions. A more native platform for 4π radiotherapy is robotically mounted linacs with greater flexibility in placing the beams but the existing commercial system is unfortunately unable to access the posterior beam angles and limited in its intensity modulation capability.

Future

The good news is that the 4π delivery challenges are likely surmountable in several ways. We showed that the collision space may be carefully modeled before treatment planning so only feasible beams are used in the optimization. The delivery trajectory can be determined based on the same model to pick a safe path traversing all beams. 3D camera technology that has already been clinically adopted can be used to provide such model in the CT sim room as well performing real time monitoring in the treatment room. On the hardware side, with the emergence of digital linacs, the beams and traveling paths can be preprogramed and efficiently executed. It was recently demonstrated that a 4π treatment involving 20 non-coplanar beams can be delivered in approximately 10 minutes with digital linac automation, making it clinically acceptable. The commercial development can take a longer time but a recently released commercial package (HyperArc) can be seen as an encouraging move towards full-scope 4π from a major device maker. Alternatively, new robotic platforms may be developed to provide more complete 4π angle access.

On the planning side, the computational challenges are far from being completely overcome. With column generation, the optimization time is reduced to several hours, which is still too long for clinical deployment. A new class of solvers based on group sparsity optimization has shown the promise of solving the non-coplanar optimization problem non-greedily. This new approach may be able to solve a complex case in significantly shorter time. Beamlet dose calculation is another challenge that needs to be managed. To minimize the difference between optimization and the final dose calculation, more accurate dose for the individual beam units is desired. Using collapsed cone convolution, the time to calculate hundreds of thousands of beamlets could still take hours to days on a CPU. Fortunately, dose calculation is highly parallel and perfect for GPU computational platform as many authors already demonstrated. Properly implemented beamlet dose calculation on GPUs could reduce the time to a few minutes or even shorter.

It is worth mentioning that with many heavily modulated static beams, there is an increasing risk of dose delivery error from the large number of small MLC segments, putting a greater pressure on the planning systems to better commission small field dosimetry and further improve the dose calculation accuracy accounting for leaf-end and tongue-and-groove effects. Instead of converting the optimized fluence maps to MLC segments in a separate and lossy step, we showed a new method of performing direct aperture optimization (DAO) without being confined to a small subset of initial MLC apertures, which prevents conventional DAO methods from achieving good plan quality for complex cases in practical computational time.

Despite automated beam orientation optimization in 4π radiotherapy, individual organ optimization weightings still need to be manually tuned, resulting potentially inconsistent results. An important development in the past 5 years is knowledge based planning (KBP) working on the premise that the dose distribution is highly correlated to the patient anatomies, which can be quantified. The same principle can be applied to 4π radiotherapy to set a clearer planning goal, or to even take a step further and completely automate 4π planning.

On the front of treatment delivery efficiency, there is no reason why non-coplanar 4π arcs cannot be implemented so the time of gantry and couch traveling is better utilized. A straightforward way is to optimize static beams first, connect them with arcs, and then optimize the beam apertures along the arcs. To implement this method, the order of beams need to be determined first, which is not a trivial task. A second pitfall is that despite the anchoring beams being optimized, the connecting arcs are not necessarily desired for dosimetry. It is likely that these arcs would need further adjustment for achieve better balance between delivery efficiency and dosimetry in 4π arc therapy.

A novel 4π planning system incorporating some if not all the aforementioned features will be available soon for evaluation. Stay tuned!

Disclaimer: This essay is not meant to be a scholarly article. The sources of information may not be clearly or exactly cited. However, please let me know if there are factual errors that need to be corrected.

NACMPA Award Committee Established

The Award Committee of the North American Chinese Medical Physicists Association (NACMPA) was established to nominate and select NACMPA awards, including NACMPA Best Paper Award and Medical Physics Community Contribution Award.

Charge:

C1. Nominate, review and select the awardees for those awards directly appointed by NACMPA

C2. Participate and facilitate the award nomination and selections process for those awards that are not directly appointed by NACMPA, but will be awarded during NACMPA meeting, and ensure the entire process follow the by-laws of our society.

Members:

1. For charge C1, the award committee includes all the Board of Directors and the EXCOM members of NACMPA (the President, the President- Elect, the two most recent Past-Presidents and a member-at-large, the current Secretary and the Treasurer), plus five NACMPA general members with expertise in one of the following areas:
    - *Diagnostic Imaging*
    - *RT Dosimetry*
    - *RT imaging*
    - *RT technology*
    - *Community activist*

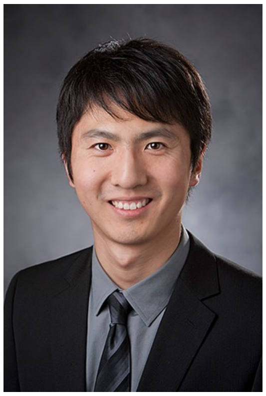
   A majority of the committee shall constitute a quorum.

   The general members can either be nominated by any of the Directors or EXCOM members, or can volunteer themselves for service. The final selection of the five members are based on majority voting of the Board of Directors and the EXCOM members of NACMPA.
2. For charge C2, two EXCOM members of NACMPA will join the award committee, either as voting members or non-voting members. The purpose is to ensure the process follows the by-laws of our society.

Terms:

1. When a committee member is also the Board of Directors or the EXCOM members of NACMPA, the term of the award committee membership follows the term of the officers, defined by the by-laws. The new officers automatically become award committee member once taking office.
2. The term for the five general members is 3 years, renewable for one additional terms.

Report on the Chongqing NACMPA Symposium Activity (1)



Taoran Li, Ph.D.
NACMPA Member

I was honored to be able to present my research at the NACMPA 2017 symposium at Chongqing, and even more so to be selected for the travel award. The opportunity provided by NACMPA for young physicists like myself to get to know and discuss with colleagues in China regarding latest topics and research is simply priceless.

During the 2-day period at the beautiful city of Chongqing, distinguished speakers and talented physicists from all over China and U.S. had an extremely exciting and fruitful exchange. Discussions on artificial intelligence, cloud-based treatment design, as well as advanced quality assurance technique were the theme of this meeting, and inspired a lot of synergy among US and China physicists. The fast growing need for consistently high quality patient care in China and increasing translational research support from hospitals will definitely lead to more knowledge exchange and collaboration among Chinese physicists from both countries.

I am extremely grateful to the NACMPA leadership for co-hosting this meeting, and providing young physicists with travel assistance. Hopefully there will be more interactions like this one between NACMPA and physicists & oncologist's community in China in the future.

Report on the Chongqing NACMPA Symposium Activity (2)

Lei Zhang , Ph.D. student

NACMPA Member

It was a great honor for me to present my research in the recent NACMPA Symposium joint with Chinese Radiation Oncology Physics Annual Meeting in Chongqing in October 2017. The title of my talk was “A novel multi-source adaptive image fusion technique for MR-based treatment planning”. During the meeting, I also learned the new trends of RT in China and connected with Chinese peers in the universities, hospitals and corporations.

The two-day meeting included invited talks by medical physics experts and proffered oral presentations from both China and the US. About 50% of the invited talks and 20% of the proffered oral presentations were given by NACMPA members. Corporate satellite lunch presentations by Varian and Elekta, and vendor displays were also included. Among many exciting topics, cloud and AI were two highlights. More specifically, remote RT via cloud platform; auto-contouring using deep learning models; auto-treatment planning using 3D dose distribution based KBP; auto-QA based on machine learning, etc. attracted broad attention. Another highlight is the MR-Linac system, a “disruptive technology” as described by NACMPA President Professor Allen Li. With both the real-time MR imaging and online adaptive re-planning possible, the “online ART” enabled by MR-Linac is moving into clinic and the “real-time ART”, an once medical physics dream is one-step closer to reality.

The meeting also provided a chance to connect with RT industry in China. After talking with industry vendors, I was able to put my research of image fusion into context of the RT development in China and to see the collaboration opportunities. The fast pace of innovation by Chinese corporations was impressive and it can be expected that more and more high quality RT products would emerge in the global market by Chinese vendors.

I would like to thank NACMPA for such a wonderful travel award to students. It’s a great way to promote the medical physics communication between the U.S. and China from the student level. Coincidentally, as a Ph.D. candidate in the Medical Physics Graduate Program of Duke University, I am spending this fall semester with the Medical Physics Graduate Program at Duke Kunshan University (DKU). This program features numerous interactions between students and faculty from Duke University in the U.S. and DKU in China. The NACMPA symposium and my recent experience at DKU are both great learning and growing opportunities and showed the importance of communications and collaborations. In line with the mission of NACMPA, I hope more of us students can learn from senior NACMPA members, grow with a solid knowledge foundation, and contribute to the innovation, collaboration and globalization of medical physics. Thank you.

医学物理词汇中英对照表(第一部分)郭超 王文弢 段晓雨 徐志岗 编缉

A
Absorbed Dose
吸收剂量
Activation Systems
活度测
Adjuvant Intent
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Air Filled Cavity Ionization Chamber
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Biological Effective Dose
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并发症概率
Cone Beam Scan
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限制条件
Continuous Slowing Down Approximation (csda)
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Cross Calibration
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Cumulative Distribution
累计分布
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曲线斜率
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Depth Ionization Curve
深度电离曲线
Depth-Dose Curve
深度计量曲线
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剂量不均匀性
Dynamic Spot Scanning
动态点扫描
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静电计
Electronic Portal Imaging (EPID)
电子射野影像
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Energy Modulation
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Equivalent Uniform Dose
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Graphite Calorimeter
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Gross Tumor Volume
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Inherent Filtration
固有滤过
Integrated Image Guidance
集成图像引导
Internal Target Volume
内部靶区体积
Ion Chamber
电离室
Ion Recombination
离子复合
Isotropic Grid
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Mass Energy Absorption Coefficient
质能吸收系数
Monitor Chamber
监测电离室
Monitor Unit
机器跳数

Multidimensional Conformal Radiotherapy
多维适形放疗
Multileaf Collimator
多叶准直器
N
Noncoplanar Beam Arrangement
非共面射束
Normal Tissue Complication
正常组织并发症
Normalized Total Dose(NTD)
归一化总剂量
Nylon-Wall Chamber
尼龙壁电离室
O
Off-Axis Ratio
离轴比
Optical Tracking Technique
光学追踪技术
Organ at Risk
危及器官
Output Factors
输出因子
Oxygenation Status
氧合状况
P
Penumbra
半影
Percent Depth-Dose (PDD)
百分深度剂量
Phantom
模体
Plan Conformity
计划一致性
Plane-Parallel Chambers
平行板电离室
Planning Target Volume
计划靶体积
Plateau Region
坪区
Poisson Model
泊松模型
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