North American Chinese Medical Physicists Association

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NACMPA NEWSLETTER

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A Message From the President

Zhigang (Josh) Xu, PhD
NACMPA President

Welcome to the Fall 2020 edition of the NACMPA newsletter.

Reflecting back on the Spring of 2020, I mentioned in the president's message how we were living in unprecedented times, dealing with the outbreak of a disease on a scale not seen in decades. As we fast forward to the present time, our world as we know has changed. Many of our members might be wondering what uncertainties next year will bring upon us. At present, there are still many questions left unanswered. For example, will the virus ever be controlled? Will the society return to normal anytime soon? Will we be able to have an in-person meeting next year? Regardless what happened, for now, we can continue to use the WeChat online platform to stay connected. I am optimistic that by working together, we can make our community even stronger.

In July of 2020, we used the newsletter and the WeChat online platform to hold our annual meeting in a hybrid format for the first time. While most of the meeting agenda was published in the newsletter, the election for NACMPA officials was carried out live on WeChat. Congratulations to Lu Wang on being elected as President-elect, and Ke Nie on being elected as Treasurer.

Due to the uncertainty of WeChat usage in the USA, we have launched a membership drive. To ensure that all members continue to receive notifications from the association, please log on to the NACMPA's website to register: *http://directory.nacmpa.org/facelets/logon.faces*. As a backup, NACMPA Telegram group has been created. To join the group, please click *https://t.me/joinchat/TscCYBdDVfFbaEWgDu2cfg*.

As the outgoing President, I thank you again for the opportunity to have been your President for the last two years. It has been a great pleasure for me to serve NACMPA. I look forward to continuing to participate in upcoming events. Wishing you and your loved ones peace, health, happiness, and prosperity in the coming New Year.

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.

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微信公众号.

Editors: Brian Wang, PhD, Zhigang (Josh) Xu, PhD

2020 Medical physicist: yesterday, today, and tomorrow

James C H Chu, PhD, AAPM Edith H. Quimby and NACMPA Hall of Fame awardee

James C. H. Chu, PhD
NACMPA Past President

When I started my graduate studies in medical physics, my nuclear physics professor advised me to rethink my choice of study concentration. After all, as he told me, medical physics is not "real physics" and the specialty of cancer radiotherapy probably will not last as new cancer wonder drugs may appear in a few years. The field of medical physics has indeed changed substantially over the years, but the field has weathered these changes well and, with its focus on improving patient care, has continued to flourish.

The advances in the equipment we use have been amazing. I used a Victoreen condenser chamber during my first medical physics lab in graduate school. We also had to go into the treatment room and manually move the chamber repeatedly to measure the Co-60 beam profile —a far cry from current scanning and detector systems with which one can scan a variety of beams to one's heart's content. Prefabricated and customized cerrobend blocks were common place when I started. In fact, because they played such an important role in our practice at the time, I spent an entire week making blocks at my first job in order to learn the intricacies of the craft. Of course, multi-leaf collimator has made a world of difference today, not only providing field shaping functions automatically but also dynamic treatment capabilities. Some of the old style treatment machines that I worked on, like betatron, van de Graaff generator, and, above all, Co-60 units, are no longer seen in modern treatment facilities; they have been largely replaced by linear accelerators, many with integrated verification imaging capabilities. The process of treatment planning has also changed significantly; I remember spending an entire month working side by side with dosimetrists to do Clarkson summations using scatter dose rulers, to take soldering wire contours, and to produce isodose contours by hand as part of graduate training. The technology has really come a long way, with today's computerized planning systems capable of 3D dose calculations with sophisticated algorithms and with some systems even equipped with artificial intelligence-mediated auto-planning.

The way we used to train medical physicists and the pathway into the field was much less structured than the process prescribed by CAMPEP now. For example, I graduated from a biomedical sciences program with medical physics concentration, and my curriculum required a wide variety of biomedical courses in addition to those in medical physics. One of my professors once said that medical physics graduates are the best prepared for cocktail parties as it's easy for us to carry a conversation with people from different disciplines. No doubt, with a standard curriculum, students and postdocs from CAMPEP accredited programs now are in general better prepared for activities in the clinic and for board exams; although some may argue that this early specialization may limit the inflow of talents from other disciplines. Another important development is the requirement to complete a residency program after graduate school or postdoctoral training. I was able to move to a faculty position at Penn right after my graduate studies. This would be very hard or nearly impossible nowadays.

Against the background of all these changes, a medical physicist's responsibility in the clinic has essentially remained unchanged over the years: we are still responsible for the delivery of quality images and accurate treatments, respectively, in diagnostic and

therapeutic settings. This is because, with our background and training, physicists are uniquely suited to take on these responsibilities in the clinic. For example, as therapeutic physicists, we are either directly responsible for or closely involved in most steps from initial patient consultation and caring of equipment to establishing/executing quality assurance programs and final treatments. In the meantime, we are always expected to do things better, faster, more efficiently, and with fewer resources. And for the most part we have been able to meet these expectations through many ways, such as internal process improvement programs, adoption of new technologies, and other factors. I encourage medical physicists to get involved with the institutional performance improvement and oversight committee at your facility (the exact committee name and structure may differ at different institutions) to share your expertise in quality assurance on a broader scale.

Medical physicists have had to deal with unexpected challenges and rapid technological innovations throughout the history of the field, and this will continue to be the case. AI technologies will certainly play an important role in automation and quality assurance throughout an entire institution in general and in the workflow in radiation oncology or diagnostic radiology in particular. We need to get educated and prepared for this technology. Some environmental factors will have an unpredictable impact as well. The COVID pandemic has forced us to take remote interactions much more seriously; some of the tasks that were once deemed impractical without face-to-face interactions are now done remotely. We have learned to be flexible and open-minded in facing challenges. Many of the changes will stay even after the pandemic is over. Support from facility administration is going to be very important to recognizing and addressing the needs of this new workflow in the changing environment. Another area of particular interest is the trend of medical reimbursement moving away from being volume-based to an episode or outcome/quality-based model. Being experts in quality assurance, physicists have plenty to contribute in this regard. A smooth and productive working relationship with facility administration cannot be overemphasized.

I remain convinced that our central role in assuring the quality of diagnostic and therapy procedures in the clinic will not diminish even in light of continued technology and environment changes. It is essential that physicists be prepared for future challenges. In addition to the technical clinical competencies for various procedures, our training program should include elements to prepare our colleagues for the future, such as healthcare issues, communication skills, AI technologies, and data management. At the institutional level, nowadays there are many CXO positions in the organizational structure (CEO, COO, CMO, CFO, CIO, CAO, CWO, to name a few). With the increasing importance of quality assurance, if not already in existence, I wouldn't be surprised to see a CQO (chief quality officer) position at more and more institutions in the near future. It is likely that the medical physicist will play an important role at the CQO office, and might even take on the position him/herself. I believe that the medical physicist profession will flourish with time and play an increasingly important role in providing quality services to patients. This is evidenced by the continuous increase of the AAPM membership. I recall that when I hosted the NACMPA dinner during the World Congress on Medical Physics and Biomedical Engineering in year 2000, a medium sized Chinese restaurant in Chicago Chinatown was more than enough to accommodate all attendants, something unthinkable today. I have found medical physicists with our ethnic and cultural background to be possessed with intellect, dedication, an excellent work ethic, and team spirit. These people will help shape the profession to meet the future expectations and challenges and better serve the welfare of patients. I am proud to be part of this group.

An interview of the AAPM 2020 Quimby Lifetime Achievement Awardee Prof. X. George Xu

Brian Wang , PhD, FAAPM
NACMPA President-Elect

The interview was conducted by Prof. Brian Wang, Director of Radiation Oncology Physics, Department of Radiation Oncology, Yale New Haven Hospital. Prof. Wang is currently the president-elect of NACMPA after serving as a board-member-at-large previously. He is a Fellow of AAPM and an oral examiner of the ABR. Prof. Wang is the treasurer and a board member of SANTRO. He received his Ph.D. from working under the guidance of AAPM 2020 Quimby awardee, Prof. X. George Xu.

Xie George Xu, PhD, FAAPM

Prof. Xie George Xu was the Edward E. Hood Chair Professor of Engineering at Rensselaer Polytechnic Institute (Troy, New York) where he had served as a faculty member for 25 years until 2020 when he became a full-time faculty member and director, Institute of Nuclear Medical Physics, University of Science and Technology of China (Hefei, China). He has been the co-founder and president of Virtual Phantoms Inc. that commercializes VirtualDose™ and ARCHER™ technologies. Prof. Xu received a B.S. degree in physics from Xidian University (Xi'An, China) and a Ph. D. in Nuclear Engineering from Texas A&M University (College Station, TX). Funded by more than $15M worth of grants (including 4 R01s from the NIH), Prof. Xu's publication list includes 2 books, 200 journal papers and 400 conference abstracts, and 140 invited talks. Prof. Xu is a fellow of AAPM, ANS, AIMBE and HPS, and a council member of NCRP, as well as a past-president of CIRMS. He has been on the editorial board of both Medical Physics and Physics in Medicine & Biology for many years. Among recognitionsthat Prof. Xu has received are NSF's CAREER Award, CIRMS's Caswell Award for Distinguished Achievements in Radiation Measurements and Standardization, HPS's Distinguished Scientific Achievement Award, ANS Compton Award for Education, ANS Rockwell Lifetime Achievement Award in Radiation Protection and Shielding, and AAPM's Quimby Lifetime Achievement Award in Medical Physics. A more detailed biographical information can be found here at https://www.aapm.org/org/history/bio/11986/.

Photo 1. Prof. Xu and former students taken during the 2009 AAPM annual meeting in LA. (From left to right) Dr. Aiping Ding (Duke), Dr. Matt Mille (NIH/NCI), Dr. Yong Hum Na (Mount Sinai Health System in NYC), Dr. Bin Han (Stanford), Dr. Juying Zhang (Kaiser), Dr. Brian Wang (Yale), Prof. Xu, Dr. Chengyu Shi (NY Proton Center), Dr. Jianwei Gu (GE Healthcare), Dr. Peter Caracappa (Columbia), Dr. Mark Winslow (Providence Hospital).

Q: Congratulations on this very deserving award. How do you feel as one of the youngest and the first who originated from mainland China to receive the Quimby award?

A: No one deserves any award, per se, as it takes a significant amount of effort on the part of the nominator, supporters, endorsers, and awards committee. I am humbled by the recognition, considering the fact that I made little contribution to the clinical aspects of medical physics. I am extremely honored by being listed with many colleagues who I respect very much.

Photo 2. Prof. Xu showed off his long-neglected Chinese calligraphy skills for this logo in front of the newly established organization at USTC in Hefei, China.

Q: What was your career path?

A: I finished college in China and, after spending a few years at a physicist/engineer job, I came to the U.S., eventually receiving a PhD in 1994 that got me into the field of health/medical physics. Among many life-changing decisions, the most impactful was perhaps that I decided to change from physics to nuclear engineering while a PhD student at Texas A&M University. The decision was triggered by the shutdown of Superconducting Super Collider (SSC） - The largest basic scientific project ever attempted in the U.S. I still remember the first meeting with my future advisor in the nuclear engineering department at TAMU, Prof. Dan Reece. He asked me an interview question: "*How many languages do you know?*" Trying to impress him, I answered: "*Two. English and Chinese*." To my dismay, he clarified: "*No, I was asking about computer programming languages*." Prof. Reece who was the director of a nuclear reactor facility at TAMU got me into a research field that I would be doing for the rest of my career – radiation dosimetry involving Monte Carlo simulations and advanced human computational phantoms. I received a couple of faculty position offers in 1994 soon after I received my Ph.D. and decided to join Rensselaer where I stayed for 25 years holding positions from assistant professor to endowed chair professor. Looking back, it has been a really long way from the day when I first entered the U.S. at the San Francisco International Airport in 1988 as an F1-visa student with only $100 at my disposal.

Q: What has inspired your research?

A. Xu: About 11 years ago, I spent an unforgettable sabbatical year at MGH. The former head of radiation physics division, Dr. George Chen, mentioned to me a book written by Dr. Michael Goitein, titled "Radiation Oncology: A Physicist's Eye View". The book makes an interesting observation of medical physics as a profession: "Unfortunately, medical physics has tended to suffer, in my opinion, from a certain cook-book attitude… My complimentary intention (of this book) is to encourage the asking of the question 'Why not?' " Clearly, both Dr. Chen and Dr. Goitein recognized perhaps the biggest challenge facing medical physicists. That attitude of "Why Not Change the World?" – a Rensselaer logo – has defined the approach I took in my research. My full-time job was not directly tied to clinical duties, so I had the luxury of pursuing topics that I was interested in. My students and I have published papers covering a broad range of topics from medical imaging (CT, PET/CT, ultrasound, MRI, interventional radiology, proton telescope) to radiotherapy (external beams of photons/electrons/protons/carbon ions, brachytherapy of Ir-192/

electronic sources, and radionuclide therapy). Very early, I realized the importance of interdisciplinary collaboration and I was able to secure joint grants with top experts in technical fields outside my training such as parallel Monte Carlo radiation transport simulations (CPU-GPU), computer vision and graphics, machine learning (DL-based auto segmentation and planning), and nanomaterials. I also forged a good relationship with clinicians who helped me understand clinical challenges. Some of my research projects yielded interesting technology (including a 3D ultrasound software called Ultra3D, a cloud-based CT organ-dose tracking software called VirtualDose that was deployed more than 26-million times in 2019 and a real-time GPU-based dose engine called ARCHER that has recently finished clinical testing).

Q: What was the accomplishment that you are most proud of?

A: I have had the privilege of mentoring nearly 60 graduate students. Today, these former students are thriving on their own including those who are medical physicists at well-known medical centers (see Photo #1). I cannot help feeling extremely content every time I think of them.

Q: What advice can you give to students and young medical physicists?

A: Steve Jobs once said to a crowd of college graduates: “Stay hungry, stay foolish.” I think what he meant was that young people should set ambitious goals and should not be afraid of asking questions and/or taking risk.

Q: How do you feel about the AAPM annual meeting going virtual?

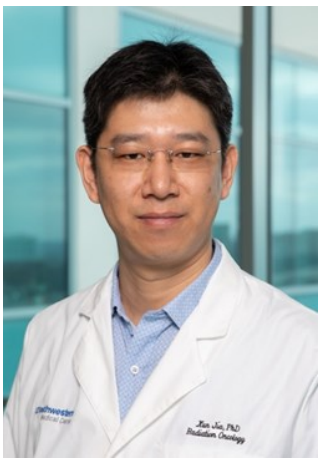
A: Attending AAPM annual meetings has been a ritual. COVID-19 has revealed a great deal about humanity. As a native of Wuhan, I agonized over what was happening in China In January this year. Today, it is incredible that this insidious virus is still crippling the society. I remain optimistic that our world will thrive soon and I look forward to the opportunity to thank my supporters in person.

Q: What do you do in your spare time?

A: In college, I participated in many sports such as basketball, soccer and volleyball. When I got older, I became interested in less-confrontational games such as tennis. More recently, I started learning to play golf which I find to be attractive because it requires a lot of physics and it is a game that challenges the player’s own physical and mental abilities. I have also liked arts. When I was in high school, I was pretty good at Chinese calligraphy – a skill that I had an opportunity to show off recently at USTC (see Photo #2). I also enjoy going to concert halls and museums to admire gifted artists. Last year, I was so impressed by what I saw at Van Gogh Museum in Amsterdam that I changed my Wechat logo to his “Sunflower” — One of the 2,100 artworks he created in his 10-year extraordinarily short and productive career.

如何准备一个成功的科研基金申请？

Funding support is essential for us to perform research. Preparing a successful funding proposal application is hence an important skill for investigators. This article gives an overview to the proposal preparation process and presents a few key components in this process. It also discusses my experience in obtaining funding supports.



Xun Jia, PhD
NACMPA Member

开展一个科研项目通常需要基金的支持。无论是从某个科研机构获得支持，还是从学校、院系、或其它单位获得支持，准备基金申请材料通常是第一个步骤。因此，书写基金申请是一个科研工作者需要掌握的技能。在这篇文章里，我想和大家分享一下我书写基金申请的心得体会，期望能够抛砖引玉，从而促进科学基金申请质量的提升，也欢迎大家批评指正。

1. 为什么要写基金申请

在文章的开始，我想和大家探讨一下为什么需要花很大的精力撰写一个基金申请书。刚开始做科研的时候，我对写东西有很大的意见，以为做好科研工作就可以了，而写基金申请则是浪费时间。随着科研工作的进展和自己事业的进步，我越来越发现写东西是科研工作很重要的甚至可以说最重要的一部分。因此端正好自己的态度才能正确地面对问题，从而会花功夫来提高基金申请书的质量。

首先，资金支持是开展科研项目的基础，而基金的申请是获得支持的第一步。做研究不是单打独斗，而是需要整个团队的合作，包括合作者，博士后，学生等。而他们花在研究上的时间需要有报酬。研究项目也需要其他的资源，比如硬件，计算平台等。这些都需要基金的支持。我们通过准备一个一百多页的文档申请来几十或几百万美元的基金来做一个自己感兴趣的项目。这样考虑的话，书写申请书其实是很划算的。

其次，准备基金申请的过程能够促使你在开展实际工作之前对项目做一个好的计划和全盘的考虑。这既包括计划一下科研项目每一个步骤所采取的策略和时间，每个团队成员的任务分工，也包括对项目重要性和新颖性的一个仔细考虑。因为一个项目从开始到结束通常需要几年的时间，花一段功夫对整个项目做一个通盘考虑，再决定是否要花几年的时间做这件事是非常必要和值得的。

另外，获得基金的支持对于我们的职业发展也很重要。从个人科研能力的角度来讲，基金项目的负责人（Principal investigator，PI）不仅需要统筹管理全局、领导团队来取得成果，也需要亲自参与很大一部分的研究工作。因此，获得基金支持是一个科研人员具有独立开展研究工作能力的象征，是同行专家对负责人之前工作成果和未来科研计划的认可。这些对项目负责人工作成果的评估和职业的晋升等都很重要。如果我们看一下那些成功的研究人员获得基金支持的经历，就会发现他们中的很多人都是从获得较小的基金支持开始，逐步提高到获得大的专项科研项目，进而到项目基金(program project grants)。这也标志着一个科研人员在职业上的进步。

2. 选题

在计划准备一个基金申请的时候，我们通常已经有了一个比较明确的研究的方向。但对于一个基金申请来讲，单单有一个方向还不够。在准备申请的阶段需要仔细考虑一下在申请的项目里要解决什么具体、明确的科学问题。所提出的问题是否是一个急需解决的重要问题？所提出的解决方案是否新颖，思路是否可行，等等。在这篇文章的后面我会谈到基金申请评定的具体标准。一个好的基金申请在选题阶段至少应该是在自己看来能够满足这些评定标准的。我的经验是，如果自己不确定一个项目是否满足了所有标准，那么可能就还不到写基金申请的时候。

3. 做好功课，了解要申请的基金

一旦确定了合适的选题，下一件事就是了解所要申请的基金。下面主要以NIH的 R系列基金，如R01，R21等为例，讨论一下我对书写基金申请的体会。如果涉及到其他类型的基金会做出特别说明。

一般每个基金都会有一个页面或文档来供申请人了解这一科研基金的基本信息以及对申请的要求，并邀请申请人提交申请（通常叫做Request for application 或类似名字）。大的研究机构，比如NIH，有长期有效的比较宽泛的研究基金机制（如NIH Parent R01）。这些用来邀请申请者提出申请来获得资助一个自己提出的研究想法。同时，一个研究机构也会不定期的发布特定的有目标性的基金信息来邀请提交申请去解决一个特定方向的问题，比如研究一个特定的疾病，开发某一项技术来解决一个问题等。我们可以经常查看基金提供机构的网页来了解有哪些可以申请的基金以及它们资助的方向，从而决定自己的想法是不是和基金的目标契合。其它需要了解的内容包括(但不限于)：基金申请的截止日期，预算要满足的条件，是否需要提交意向书（letter of intent）等。一些针对于学生的奖学金（fellowship）或者职业培养的基金（如NIH的K系列）等对申请人往往有一些特定的条件，比如国籍，毕业年限等。准备申请之前需要仔细检查是否满足条件。如果有不确定的地方，可以和基金提供机构的相关联系人确认一下。

4. 具体的目标页（Specific Aims）

NIH的申请一般需要一个一页的目标页。在评审基金的时候，很多专家都是通过这一页来获取对整个申请书的第一印象。所以不夸张的说，这一页文档应该是基金申请材料中最重要的一项。申请人需要通过这一页来说服评审人其项目的重要性、新颖性、可行性，以及为什么申请人和团队适合开展这个研究。这一页也包括了所提出的科研项目的中心假设以及计划达成的阶段性和全局的目的。这一系列的论述通常需要可靠的数据支持。

按照我的理解，一个有效的目标页按照顺序通常应该包括以下几方面的内容：1）开篇介绍，2）需要解决的问题，3）现有状况以及为什么急需解决这一问题，4）怎么解决，5）具体的目标，6）总结。一个研究项目一般可以有三个左右的具体目标（Specific Aims）。我们需要清晰地表明这些目标的具体定义，比如在项目的某一个阶段实现什么目的。几个具体目标之间的相互逻辑也要表述清楚，比如综合起来这几个目标如何实现最终的目的。需要注意的是基金是给评审人看的，即所谓的同行评议制度。在基金评审中，评审的专家一般会对大的研究方向很了解，但他们和申请者可能会有不同的研究经验和研究方向。所以一个好的目标页要针对他们有所准备，让他们能够明白并理解你的思路。

因为有长度的限制，书写这一页需要花很大

功夫。要千锤百炼、言简意赅，把问题的来龙去脉讲好，把基金申请的重点突出出来，把自己的思考变成同行的认同。我的体会是功夫花在这一页的准备上是非常值得的。写好一个目标页可以对后续的申请书的主体部分有个好的计划。因此我通常是从这一页开始准备一个基金的申请。花一段时间写好目标页之后，后面的书写工作就可以围绕目标页里面的内容来展开和论述。

5. 基金申请书的研究计划文档与评定标准

每个基金申请的基本信息页一般会指明在申请书的研究计划这一文档要包括哪些方面的内容。同样以NIH的R系列基金为例，需要包含的三个部分是所提出的研究项目的重要意义（Significance），创新性（Innovation），和研究方法（Approach）。这三部分实际上涵盖了两个方面的内容：为什么要做这个研究（Should it be done?）以及如何做这个研究(Can it be done?)。这三部分也正是NIH评定一个基金申请的五个具体条件中的三个。所以，有针对性的写好一个满足这三方面要求的申请书并突出特点十分重要。

- 重要意义（Significance）

这个部分需要突出的是所提出的研究工作的重要意义。通常评审人考虑的是，假设这个项目能够成功完成，它所产生的意义有哪些。书写这一部分的时候，可以论述所针对的疾病的严重性，临床上的困难，当前现有技术对解决某一个问题的不足等。需要指出的是文无第一，对于同一个项目的具体意义，不同的人可能会有不同的理解。所以申请者需要千方百计地把计划开展的项目的问题和思路讲透。项目的意义要有证据支持，具体化，数字化，而不要讲空话。比如我们可以明确所要提出的研究工作对治疗结果的定量的影响，如肿瘤控制率，生存率的提高等。有的时候我们也需要跳出传统的、我们熟悉的角度来论述项目的意义。除了常见的提高生存率、肿瘤控制率等指标，有些工作也可能特别适合解决某一个特定条件下的问题并具有特别的意义，比如提高不发达或资源受限的地区的医疗水平，降低医疗的成本和价格等。这些指标也可以用来论述项目的意义。

这一部分很重要的一点是要注意阐述新的解决方案和传统的、现有的方案的比较。很多提出的解决方法虽然很新颖，但是如果不能论述相比于现有的方法能够对解决具体问题有很大的帮助，那么在评审的时候可能就会被质疑项目的意义。以最近几年非常热门的人工智能为例，虽然它在很多问题上展示了很大的潜力，但写基金申请的时候不可回避的问题是在解决具体的问题的意义上，人工智能方法比传统的方法有哪些实际的好处。另外，书写这一部分的时候，还要注意不要把它写成对于领域的一个综述，或者对研究现状和历史的罗列，而要在这些内容上有逻辑地论证自己要解决的问题的重要性。

- 创新性（Innovation）

创新性指的是所提出的研究工作和现有的工作比有哪些新的东西。对于我们物理师来讲，我们提出的研究项目通常专注于开发新的技术。那么最直接的意义上，我们对一个研究工作的创新性通常会被理解为技术上的创新，即用一个新的方法解决了一个问题。但其实创新也包括其它的意义。比如新的技术所带来的新的临床手段，从一个新的概念角度研究一个基础的医学问题等。把几个传统的技术重新整合得到新的功能也可以论述为创新。另外，有的

专门的研究基金项目会对创新有特别的定义。以NIH Academic-Industrial Partnership为例，申请基金的指导信息上面特别强调所采用的技术可以不是全新的，但因为这一项目的目的是面向用户开发可用的产品，创新性也可以体现在研究开发的成果赋予了最终的用户哪些新的能力。所以详细解读基金申请的指导信息来理解特定的要求对写出有针对性的论述是很有必要的。

- 研究方法（Approach）

以上两个部分论述的是为什么要做这个研究（Should it be done?），这个部分则针对的是如何做这个研究(Can it be done?)。 一个好的基金申请要有一个严格的、详细的计划。我的理解是，在写这一部分的时候需要把自己放在项目执行人的角度来仔细考虑如何详细地进行研究。

这个部分通常分为几个章节，每个章节针对一个特定的研究目标。对于每个要实现的目标，可以细分为子目标，然后再书写具体的研究计划内容。要写的内容包括大到在各个特定的时间点，比如以季度为单位，要完成哪些预计的计划，小到对每一个步骤需要采取的具体方法和手段，衡量工作成功的量化指标，以及统计方法来判断是否满足指标等。注意不要泛泛地提一些人尽皆知的一般性的研究步骤，而是要注意突出针对自己研究的问题来设计研究计划。

不同于针对基础科学的研究项目的申请书，对于我们通常熟悉的针对于技术开发的研究项目的申请书来讲，研究方法中包含一个假设检验步骤并不是必须的。但是我认为在申请书中提出一个统计假设并进行检验还是有好处的。一方面，这可以使得研究步骤更有针对性，对于研究成功与否的评定更定量化。另一方面，基金的评审人也通常习惯了审阅这个风格的申请书，加入一个假设检验可以让他们更容易的理解提出的工作内容。对于一个针对于技术开发的研究项目，通常的假设可以是所开发的技术相比现有的方法对某一个指标能够提高多少。这里可以呼应Significance的章节。在Significance章节里面应该已经提到了这个研究项目的量化的意义，所以在Approach章节中需要对这个量化的指标进行具体地、科学地验证，从而达到对研究项目成功与否的一个定量的结论。

一般在这个章节中还要包括对我们前期已经取得的相关研究结果的表述。这有两方面的意义。第一，这一段可以表明我们之前的研究工作已经取得哪些成果，揭示了哪些问题。这对将要进行的研究奠定了基础。同时，这一段表述还可以用来强调研究团队的资质，比如之前的研究成果发表了哪些高质量的文章，会议报告等。

在书写Approach章节时需要注意以下几个问题。1）要考虑好周全的计划。不但要明确书写如何一步步的完成计划的工作，也要对于可能出现的潜在问题和可能的解决方案进行简洁的讨论。2）不同的具体目标之间应当尽量减小相互的依赖性。如果一个后续目标的完成取决于之前一个目标的结果，那么一个可能的问题会是，如果之前的目标没能够达成，后续的目标的研究计划也就不能进行了。3）统计分析非常重要。准备申请书的时候需要一个统计专家对项目的统计计划部分进行分析并对样本数进行估计。这一部分还要包括统计检验的具体模型，方法和步骤等。

6. 其它部分

除了上一个小节里面提到的评定一个基金申请的三个条件以外，另外两个条件是申请团队（Investigator）和研究环境（Environment）。所以一个完整的、高质量的申请书也要对这两方面进行充分的准备。

针对Investigator条件，从团队的角度来讲，需要考虑的是这个团队是否有资质完成所提出的项目。通常来讲，一个团队的人员要包括技术开发，临床验证，统计分析等方面的能力。对于每个团队成员的资质，一般是通过Biosketch来体现。现在的NIH Biosketch都要求有一段Personal Statement。可以利用这一段来详细说明之前的研究经验，成果，以及适合领导或参与这个研究项目的原因。这一段最好要针对不同的科研项目进行有针对性地书写。

对于Environment这一条件，NIH的基金会基于两个文档，Facility和Equipment，来进行评定。这两个文档的侧重点不同。Facility专注于大的环境，既包括硬件方面的条件，比如仪器、临床环境、办公空间等，也包括软性的条件，比如研究环境，和其他相关院系的合作关系等。如果研究的项目中需要用到其他的专业人员的支持，比如一个core facility的支持，相关的信息也要列出来。Equipment则专门用于列出所提出的研究工作中需要用到的仪器，包括硬件和软件等方面。这两个文档的准备应该围绕将要开展的研究工作来进行，表明自己的研究环境具有足够的条件来保证研究的顺利完成,而并不需要泛泛的罗列出很多的仪器等。

另外，一个基金申请书中还需要准备下面几个方面的内容。

预算。做项目预算一般比较直接，把所需要的经费列出来就好。应该根据具体的需要来确定预算的金额。需要注意的是每个基金提供机构对于预算都有明确的要求，比如哪些花销是允许的，上限是多少等。基金申请需要一个对预算进行详细的说明（Budget justification），列出每一项预算的原因。基金中用于支持研究人员工作的部分要注意说明每个人的资质和在项目中的具体任务和责任，以及在这个项目中计划要花费的时间等。需要注意的是每个人计划在项目上的所花的时间要和计划的任务量相符。同时另一个需要避免的问题是项目团队中有多个人被计划来做同样的工作，这很容易引起评审人的质疑。

Letter of support。基金申请材料中可以包括一些信用来表明写信的人对研究项目的支持。一般来讲，如果研究过程中需要和一些人合作，合作的人可以写一封信来表明对项目知情而且愿意提供合作。也可以邀请一些专家来写信说明对项目意义的认同。

基金申请材料中其它的文档可能还包括和Human subject相关的文档，Animal study相关的文档等。是否需要包含这些文档取决于具体的研究内容。准备这些文档一般比较直接。按照具体的要求并根据研究计划写出相应的文档就可以。需要说明的是这些文档的要求可能会随时间变化，比如NIH会不定期的更新一些具体的要求。所以每次准备申请材料的时候需要检查一下最近的要求，以确保所准备的文档满足要求。

7. 早做准备，不断迭代中提高

一个基金申请书的准备过程不是线性的，而是一个迭代的过程。凡事预则立，不预则废。尽早开始准备申请书是很有必要的。一般可以按照最终的提交日期来反推并制定申请书的准备过程。当研究项目的内容和计划已经大概形成概念并且申请者决定开始申请了，可以先花时间把除了研究目标页和研究计划的其余文档

准备完成。之后对于研究目标页和研究计划，应当尽早完成第一稿。根据我的经验，如果花很多功夫在书写第一稿上面，往往很多的时间会被浪费。相反，尽快写完第一稿后会对整个项目的全局有个更好的了解，从而能决定后续如何进行修改。

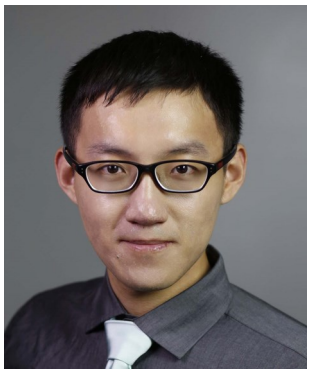
完成第一稿之后，最好能留出一两个月的时间来不断迭代和修改。我的体会是如果把一个申请书放几天再回头看，通常能发现很多新的问题或者有了很多新的想法。在修改的过程中让有基金申请经验的同事来阅读申请书并提出意见也是一个很有效的提高申请书质量的方法。

在注重书写内容的同时，也不能够忽略表达方式。一个基金评审专家通常有六周左右的时间来评审一些申请书。但是很多评审人都会在最后一两周的时间里面突击阅读这些申请书。因为花在每个申请书上的评审时间会被压缩，对基金的第一印象就变得非常的重要。所以在修改基金申请的过程中应当尽可能的突出重点。这包括两个方面的工作。一个是英语的表述。对于我们英语不是母语的研究者来说，花时间来修改英语表述很重要。很多时候按照中文思路翻译过来的英文并不是很准确，所以很有必要不断的推敲，尽量避免引起含糊不清的表述甚至是歧义。最好能有英语是母语的人帮忙审阅或修改申请书。第二个方面是表达的格式。整个文档的格式需要尽量清晰。花些时间来排版和作出漂亮的图表对提高第一印象是非常重要的。为了突出重点，可以适当的突出一些重要的文字内容，比如利用下划线，斜体字等。但是也要避免太多的格式变化，以免给人喧宾夺主的印象。

最后我想说的是，准备一个基金申请是一个复杂的过程，基金的评审也有一定的不确定性。每一次申请的结果往往令人失望。因此心态很重要：提交申请前做最好的准备，提交申请后做最差的预期。但是，如果我们认同科研基金对于研究的重要性，希望得到基金的支持来开展自己喜欢的研究，那么就一定不要放弃！不断坚持写申请，就会不断提高申请书的质量，最终一定会获得资助。往往获得第一个资助是最难的，之后随着经验的提高，获得资助会慢慢变得相对容易些。

写了这么多，希望能够对大家有所帮助，也欢迎大家的讨论，共同提高。

Deep Learning in Medical Physics



Yang Sheng, PhD
NACMPA Member

Sua Yoo, PhD

From Inception to Clinical Deployment: Duke's Experience of Inventing and Integrating AI in Routine Clinical Operation for Breast Treatment Planning

Breast cancer is the highest occurrence cancer among female. Breast radiation therapy treatment focuses on not only local control, but also the long term toxicity given the high 5-year survival rate. Our institution sees high breast patient volume in general. Our Radiation Oncology department uses tangential style electronic compensation technique to design best available treatment plan for the patient, a.k.a. ECOMP. Unlike other popular breast treatment planning techniques, e.g. IMRT or VMAT, ECOMP provides uniform dose distribution within the irradiated volume without invoking inverse optimization, hence it costs at the much lower 3D technique rate. One limitation of this technique is that the dosimetrist needs to iteratively and manually paint the fluence map until the dose distribution is clinically optimal. This motivates us to use artificial intelligence (AI) to enhance the efficiency and quality of our clinical workflow.

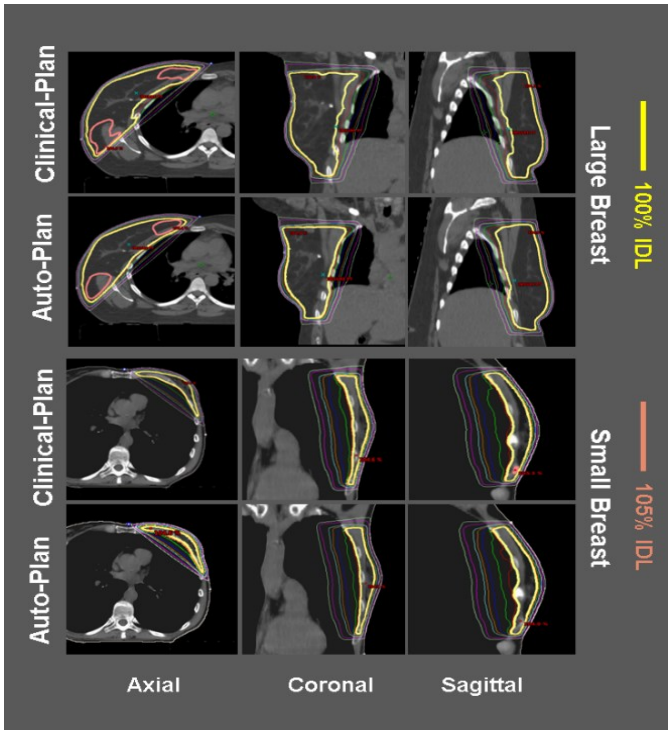


Figure 1 Isodose comparison between manual clinical-plan (first and third row) and AI auto-plan (second and fourth row) for one large breast patient (top two rows) and one small breast patient (bottom two rows). Yellow isodose line (IDL) denotes 100% and pink IDL denotes 105%. Note the 100% cover the entire breast tissue while 105% hot spots are minimal.

1. Inception

The project was initiated on Oct 2015. A pool of breast cases previously treated with whole breast radiation therapy (WBRT) covering a wide spectrum of shape and sizes from Duke University Medical Center was approved by institutional review board (IRB). All plans were treated with 200 cGy fractional dose to a total of 25 fractions, mixed with single energy (SE, 6MV) and mixed energy (ME, 6/15MV).

Our AI planning tool is composed of four key components: 1. Intelligent energy selection; 2. Anatomy-based fluence estimation; 3. Patient specific fluence fine tuning; 4. Automatic beam placement.

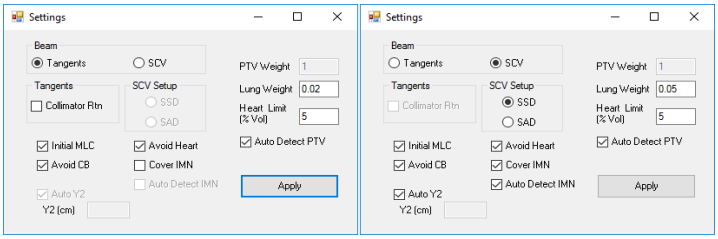


Figure 2 User interface design of the automatic beam setting tool.

1.1 Auto fluence tool

1.1.1 Intelligent energy selection

Clinically, planner often judges the energy choices for a specific patient primarily based on their experience. A lack of energy selection guidance adds to the workload for planners and thus impedes the clinical workflow especially for less experienced ones. Using Principal component analysis (PCA), the energy selection was determined in the 2D anatomy feature space (first two components) projected onto the beam's-eye-view.

1.1.2 Anatomy-based fluence estimation

Our clinical treatment planning platform, Eclipse™ (Varian Medical Systems, Palo Alto, CA), offers a module to generate the electronic compensator ("irregular surface compensator") for each beam individually. It attempts to reach a constant dose level at a specified depth (e.g. 40% depth), therefore, it does not take into consideration the 3D dose distribution and dose heterogeneity often arises. We utilized the random forest (RF) model to characterize the relationship between input features (shape based features, including grey level intensity, penetration depth in breast target, penetration depth in lung etc.) and output variables

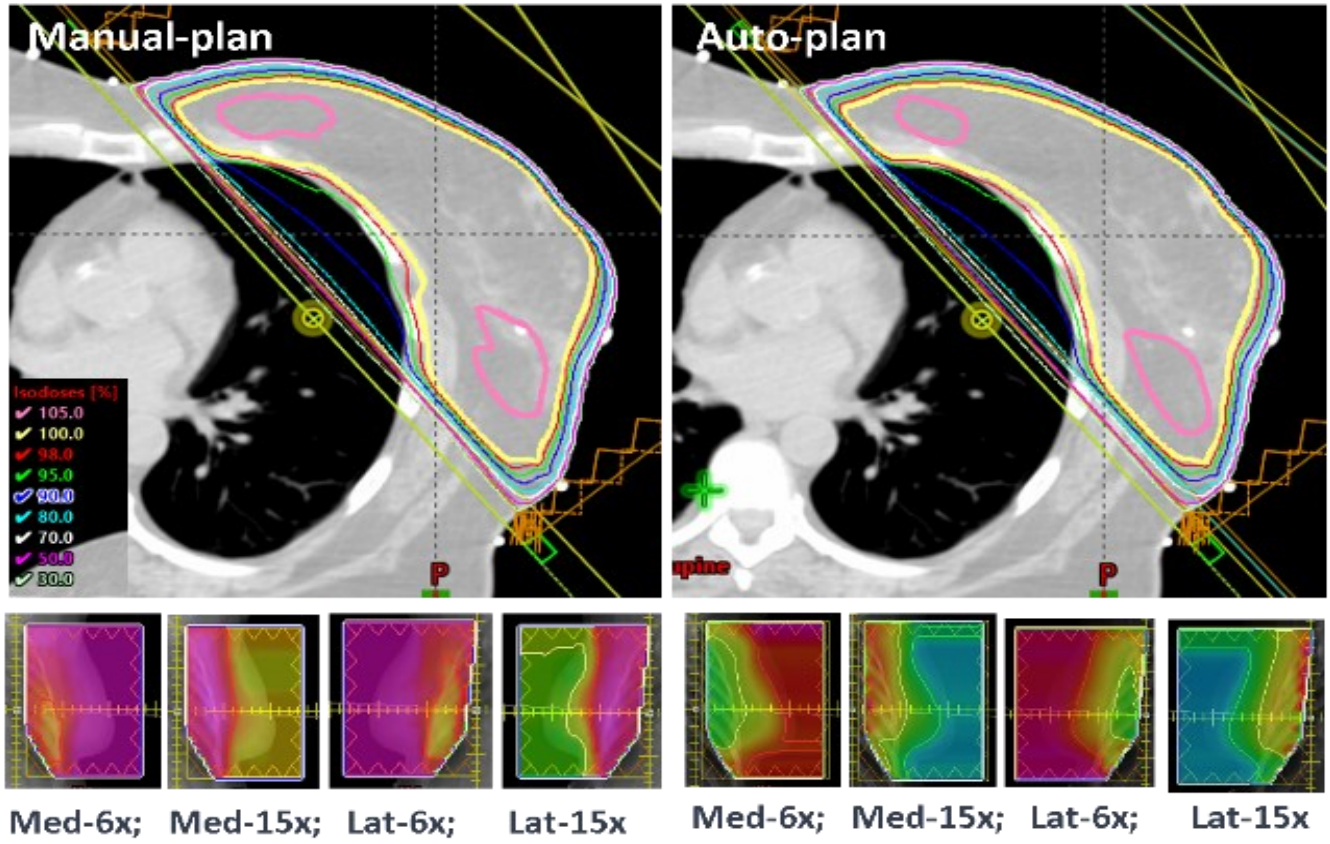


Figure 3 Isodose comparison between the manual-plan (left) and the auto-plan (right) for a medium-sized breast patient. The final fluence map for 6MV and 15MV are shown at bottom. Note the intensity prediction also includes the skin flash region, and different energies have different patterns.

Table 1 Summary of key dosimetric endpoints and execution speed from commissioning results.

	Manual-plan Mean ± SD	Auto-plan Mean ± SD	Wilcoxon signed rank p
Target V95% [%]	96.7 ± 5.0	96.8 ± 4.9	0.888
Target V105% [%]	21.6 ± 29.8	20.4 ± 30.5	0.215
3D Dmax [%]	109.6 ± 1.7	109.6 ± 1.9	0.580
Heart Dmedian [%]	1.2 ± 0.8	1.2 ± 0.9	0.419
Ipsi- Lung Dmedian [%]	4.5 ± 1.6	4.5 ± 1.7	0.419
Planning time [min]	110.2 ± 62.8	6.4 ± 2.1	< 0.001

(pixel-wise fluence intensity). RF is a highly nonlinear model which initializes decision trees using randomly sampled data from a training dataset and generates a prediction by averaging the outputs from all trees. The intensity prediction also includes the skin flash region, and different energy has different pattern.

1.1.3 Patient specific fluence fine tuning

The fluence map generated from the RF model inherits the plan quality from the training cases. However, the physician may have patient-specific requirements for the target coverage or a constraint for a high-dose volume or hot spot. This step offers physician the opportunity to interactively fine-tune the 3D dose distribution. The dose are adjusted in real time while balancing dose contribution from both beams. Geometric and dosimetric parameters (penetration depth, dose at anchor point etc.) of these dose anchor points were summarized from training plans to serve as baseline values and these parameters can be further adjusted to provide specific coverage or hot spot dose reduction for any query patient.

1.2 Auto beam placement tool

In parallel, we launched a project which focuses on the automatic beam setting for tangential style WBRT. This tool compliments the fluence map prediction tool, which combined make a more streamlined treatment planning workflow for WBRT.

We utilized goal driven optimization to determine the optimal beam setting for a specific patient. The goal was defined by physician which they use to balance common trade-offs, such as breast volume coverage and lung dose. The AI model was trained based on the final beam setting of previously treated breast patients. We integrated this user interface in Eclipse™ Scripting Application Programming Interface (ESAPI), as shown in Figure 2.

2. Commissioning of the AI planning Tool

The commissioning of this AI planning tool was

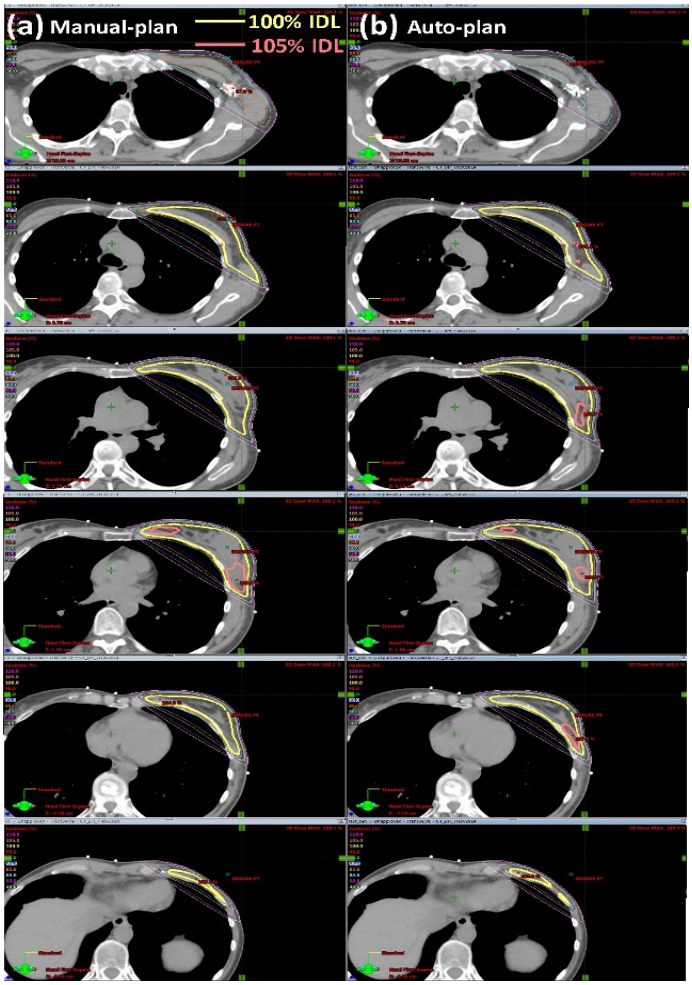


Figure 4 Slice-by-slice isodose comparison between (a) the manual-plan and (b) the auto-plan. Yellow isodose line is 100% and pink isodose line is 105%. The overall 100% dose coverage is identical between the two plans while the auto-plan achieved slightly better 105% hot spots.

carried out from Nov 2018 to Jan 2019. The commissioning process focused on the auto fluence tool. The physicist in charge of breast service team performed the commissioning. Thirty whole breast or chest wall cases were planned simultaneously with standard care of manual planning and the AI planning tool. Patients were treated with these manual plans after physician's approval. Example isodose and fluence comparison between the manual-plan and auto-plan is shown in Figure 3. As can be seen, both plans shared similar 100% isodose coverage (yellow). Auto-plan provided improved 100% coverage around the chest wall where the planner often struggles to balance against the 105% hotspot (pink). Both plans showed similar 105% volume in terms of size and location, indicating equivalent plan quality. Interestingly, the fluence map pattern between 6MV and 15MV was not identical between two plans. It suggests that the AI tool captured the high level pattern of balancing fluence contribution, a.k.a. more high energy towards chest wall and more low energy towards skin flash, while not exactly duplicating the fluence intensity from manual planning.

In Figure 4, slice-by-slice isodose line is compared between the manual-plan (left) and auto-plan (right). Again the 100% isodose line (IDL) is comparable between two plans (yellow). Auto-plan showed more consistent 105% hotspot volume across superior-inferior direction, indicating a more consistent hotspot volume management while maintaining adequate prescription isodose coverage.

The commissioning results demonstrated the two planning methods had equivalent plan quality, and about 17 times faster (ave 6.4 min vs 111 min). During this commissioning phase, we also actively collected feedbacks from our dosimetrists on interface improvements, further customization requirements and refinement ideas. The version 2 release of the AI tool is planned for 2021.

3. Clinical Deployment

The AI breast planning tool became online in May 2019 at Duke University Hospital. And in Oct 2019, it went online for Duke Raleigh Hospital, an affiliated satellite hospital to Duke Health System. At this phase of study, the auto fluence tool was made available and the auto bream placement tool was under testing and refinement, and will be commissioned in later phase of the study. As of Oct 2020, we have treated 490 breast patients at Duke University Hospital, with additional 247 patients at Duke Raleigh Hospital, which in total saved thousands of planning-hours. A comprehensive report about the clinical experience with this AI planning tool is forthcoming.

Our closed-loop process of inventing, developing and commissioning AI tool within a radiation oncology department demonstrated the advantage of integrating the research development team into clinical operation team. We anticipate further collaborations between the teams in other clinical services to provide better AI solutions in the real clinical setting.

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Ethos Therapy – An AI powered online adaptive radiotherapy

What is Ethos system?

Bin Cai, PhD
NACMPA Member

Ethos radiotherapy treatment platform is the latest radiotherapy solution developed by Varian Medical System. One of the design goals for Ethos system is to provide a rapid and robust kV CBCT guided online adaptive RT process which can deliver adaptive treatment in 15 to 30mins. Ethos therapy comprises three fully integrated components: Ethos radiotherapy system, Ethos treatment management, and Ethos treatment planning. The foundation of Ethos therapy is Adaptive Intelligence, which uniquely integrates advanced multimodality images and artificial intelligence, enabling clinicians to see more, know more, and treat more precisely.

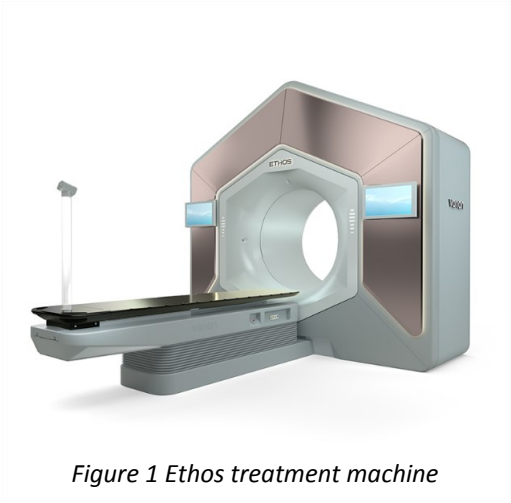


Figure 1 Ethos treatment machine

What is the difference between Halcyon and Ethos?

On the hardware side, the Ethos machine is based on Halcyon 3.0 platform. It is coupled with a compact and rapid rotation ring gantry medical linear accelerator which can provide 6MV flattering filter free photon radiation beam. Other innovative technologies include a cutting-edge double-stack multi-leaf collimator (MLC), a high quality kilovoltage cone-beam computer tomography (CBCT) system and a robust workflow to deliver highly efficient and precise radiotherapy treatment.
On the software side, unlike Halcyon which uses Eclipse as the treatment planning system and Aria as the treatment management platform, the Ethos utilizes a new and integrated treatment planning and monitoring system (TPMS) with artificial intelligence tools to help organ contours, plan optimization and treatment monitoring. Ethos TPMS consists of three major workspaces: RT intent, Plan Review and Treatment Monitoring. The Ethos TPMS sever stores planning images, treatment plan, on-treatment images and treatment record. Overall, the Ethos therapy is a comprehensive and revolutionary new radiotherapy platform. It is capable of providing both regular imaging guided radiotherapy (IGRT) as well as online adaptive radiotherapy. From initial planning to on-couch adaptation and treatment monitoring, the entire treatment process is patient-centric and personalized.

What is the planning process on Ethos?

In the TPMS, the RT intent is the starting place to initiate the treatment planning process. The RT intent hosts three workspaces: plan directives, images & contour and dose preview. In the planning directives, clinicians provide RT prescriptions and clinical goals. These clinical goals will later drive the optimization process. The plan directives can be saved as a template and used for other patients on the same protocol or with the same radiation dose scheme.

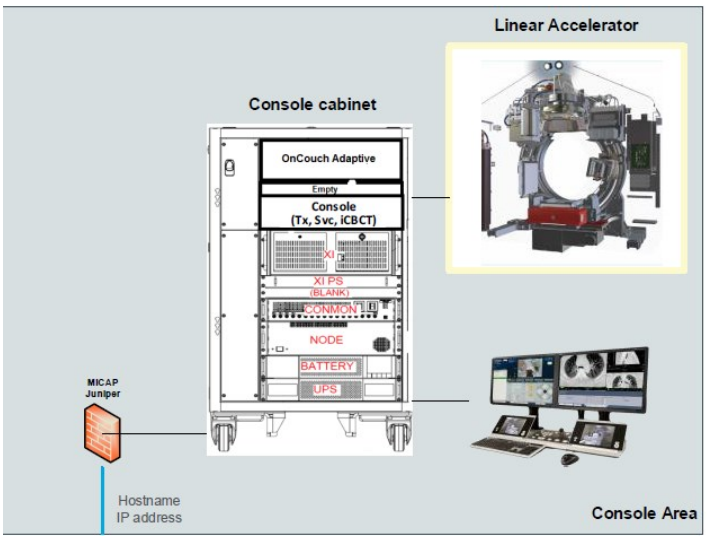


Figure 2.0 Ethos Ecosystem

The image and contour workspace allows clinicians to review images and perform delineation. Multiple secondary images can be imported as supporting images to aid the contour process; contour self-check functions, including overlap check, discontinuity check, and .etc. are built-in to help evaluate the integrity of structures.

The dose preview space provides a real-time three-dimensional dose distribution review. It allows to quickly assess whether the RT intent is achievable and permits real-time interaction with the dose distribution through DVH and goal ranking manipulations.

After initial dose review, the RT intent can be authorized and the system will generate final plans based on clinical goals and priorities. Currently, the system can generate template IMRT plans with seven, nine and twelve fields, and VMAT plans with two and three arcs in one run. The final dose distributions, DVHs and plan quality metrics can be evaluated in plan review workspace.

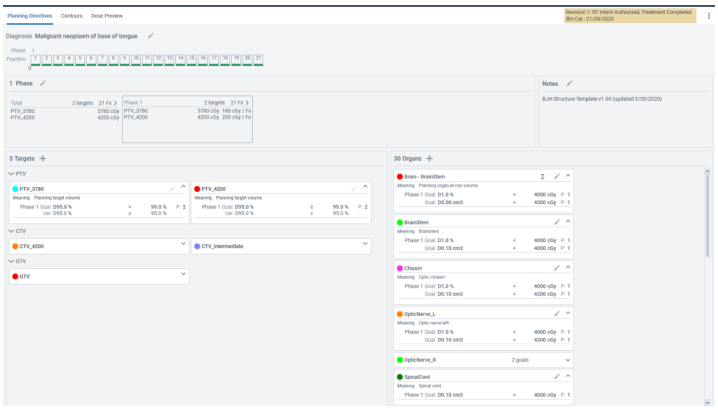


Figure 3 RT intent workspace with planning directives.

What is the online adaptive workflow on Ethos?

The adaptive treatment started with acquisition of high quality kV CBCT images. There are eleven protocols with various scan time, kV and mAs settings. The iterative CBCT (iCBCT) option is available for all image protocols. After image acquisition, the system automatically segments the influencer structures, generates target structures based on the treatment day images and displays the contours for review. The influencers are a set of common normal structures based on the treatment sites. These influencer structures have impact on the target generation, therefore need to be thoroughly reviewed. After all contours are approved, the system automatically generates two plans: scheduled plan and adaptive plan. The scheduled plan is the initial plan calculated based on the treatment day images and anatomy; the adapted plan is the original plan re-optimized based on the preset clinical constraints. In the plan review workspace, the users can easily assess the plans based on preset plan metrics, dose distribution and DVH for each structures. While the plans are being reviewed, the system automatically send both plans to Mobius3D for a secondary dose calculation based plan QA. The user will decide between scheduled plan and adaptive plan based on the dose distribution and constraints for treatment delivery.

What are the key AI components in the system?

An AI algorithm is used to contour normal struc-

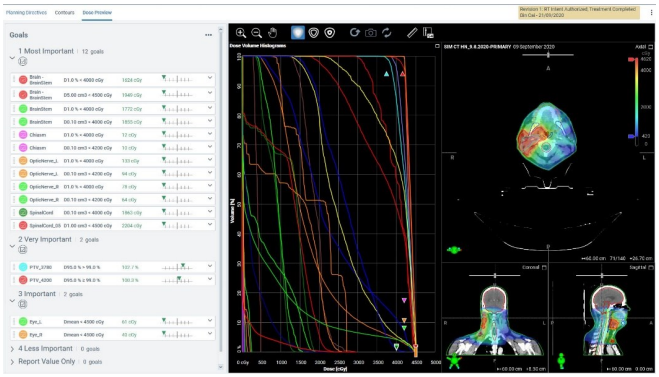


Figure 4 Dose preview workspace with a list of clinical goals, DVHs and three dimension dose distribution.

tures named influencers for a treatment site. The AI models are built based on a convolutional neural network with training dataset provided from multiple institutes, and is thoroughly tested and validated before release. Ethos uses full image deep convolutional neural networks with proprietary architectures that share many similarities with U-Net and DenseNet. The network itself takes the full 3D image dataset as input and returns the same size of segmentation as an output during inference.

AI is also used to drive an intelligent optimizer engine (IOE). The IOE is used in dose preview generation and the automated planning algorithm. The IOE first translates the clinical goals to objective functions and creates quality functions (Q-functions) to monitor the progress of optimization. It also handles the overlap structures and conflicting objective settings by automatically setting up PRV or ring structures that mimic human-planner thinking process. For the optimization monitoring, the IOE iteratively works on the objective functions by priority set up for each structure. Unmet goals with higher priority receive attention before unmet goals of lower priority and when all goals are met, additional effort is place to reduce the dose to normal tissues as much as possible. The ultimate goal of IOE is to automatically generate robust plan meeting all clinical goals as quick as possible.

What are the WashU experiences with Ethos system so far?

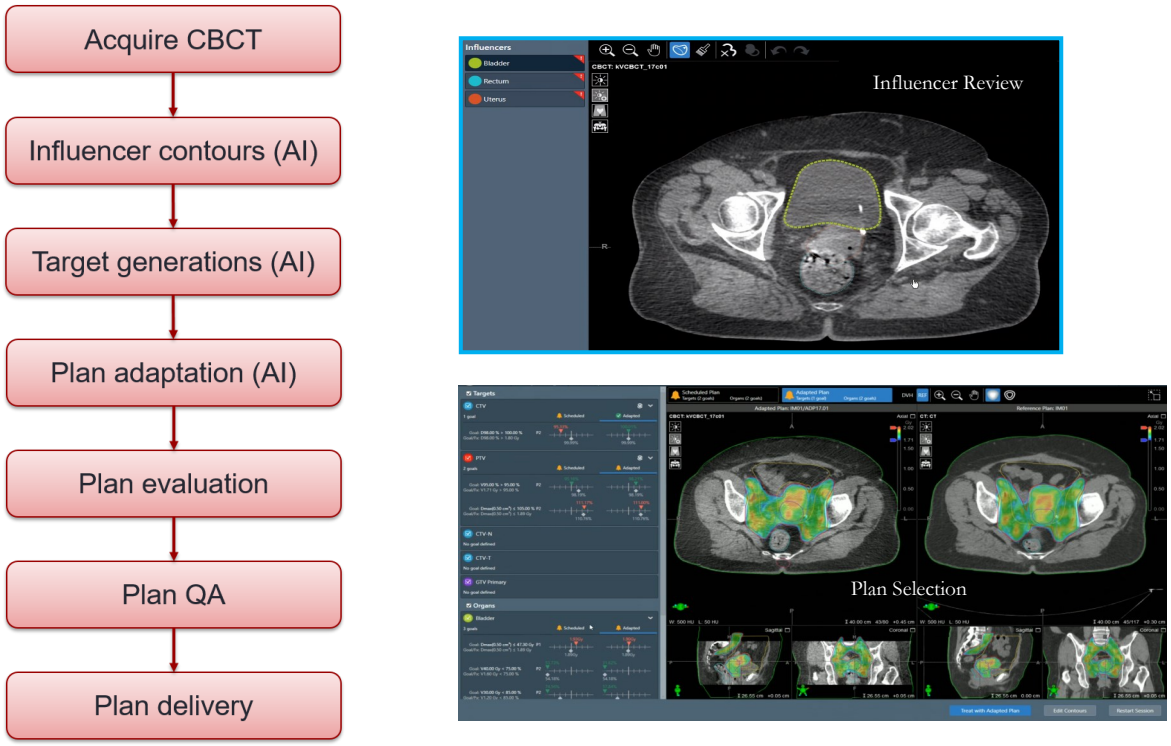


Figure 5 Online adaptive treatment workflow with sample influencer review and plan selection interfaces.

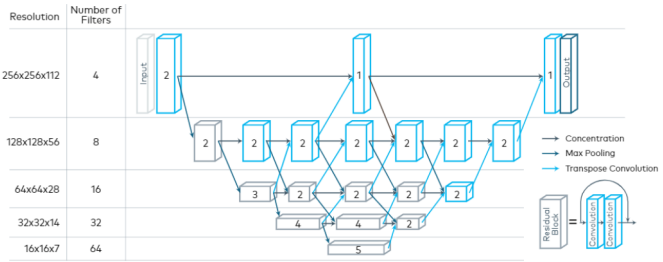


Figure 6. An example of Varian's deep convolution neural network architecture.

The Washington University School of Medicine is the first one in the United States to install the Ethos platform. As the pioneer institution, our radiation oncologists and medical physicists were tirelessly working on the development and clinical implementation of this system. Within six months, 115 patients with more than 2000 radiotherapy fractions have been delivered through the IGRT workflow using this system. For adaptive treatment, more than 20 patients were recruited for a simulative online adaptive trials for abdominal and pelvic disease sites. In June, we treated the first online adaptive clinical case in the Unites States. Currently, our team is focusing on (1) widening the application of this platform to treat more disease sites; (2) the development of multiple clinical trials to prove the benefit from online adaptive radiotherapy; and (3) the development of robust tests and quality assurance approaches to validate and improve the AI tools.

What are some clinical challenges when implementing Ethos system?

It is truly a team effort from physicians, physicists, therapists and dosimetrists to successfully implement online adaptive radiotherapy. Therefore, it is critical to establish a robust online adaptive workflow with appropriate QA/QC measures prior to clinical implementation. Ethos is the first system that bring in AI to daily clinical treatment, therefore, a validation on AI tools and knowing the limitation of AI tools is important. Unfortunately, guidelines and policies are still forthcoming on commissioning and validation of AI tools in radiation oncology. A robust motion management and gating solution on Ethos is still under development. On clinical side, the benefit of CBCT-guided online adaptation still need to be investigated with strong clinical evidence through multi-institution trials and effort.

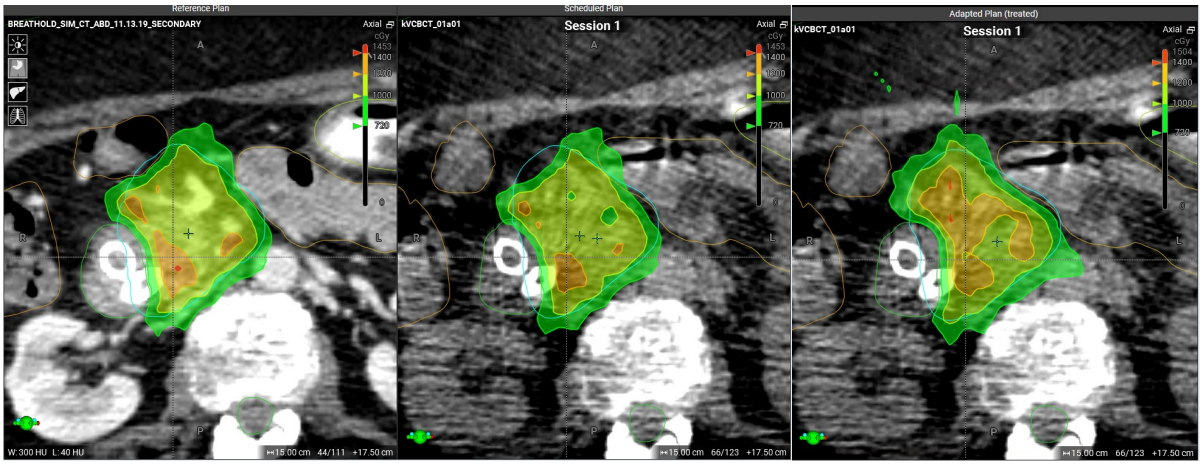


Figure 7. An abdominal adaptive case demonstrated that patient benefit from plan adaptation. Left: initial plan with constraint dose (dark green) curved out from duodenum (light green) and small bowel (yellow). Middle: scheduled plan calculated on treatment day with constraint dose invade duodenum and small bowel due to changes in OAR location. Right: adaptive plan showing dose curved out from duodenum and small bowel after plan re-optimization.

Automation in Radiation Oncology

Elisabeth Van Wie, MS DABR, Radformation

Automation is transforming healthcare, especially in radiation oncology. This transformation allows for more advanced, complex treatments while increasing safety and efficiency in the clinic. To keep up with the increasing demands of advanced treatments, clinicians need software that evolves with new technologies. One way automation aids physicists is by automating more complex chart checks and treatment planning. From contouring to on-treatment weekly checks, automation is a way to bring safety, time savings, and efficiency to the workflow.

Radformation physicists witnessed clinical errors firsthand which aligns with RO-ILS findings. With 4,000 incidents and near misses reported to RO-ILS in 2019, it is clear that errors occur universally. The data showed that 62% of the reported errors occurred in the re-treatment stages whereas 26% occurred on-treatment. Following standard recommendations, many of these errors are caught during the physics chart check before the patient starts treatment. Up until recently, there was no standard on what should be checked during a chart review. The published recommendations of TG275 have defined a new standard for our field: 150+ pre-treatment checks and 50+ on-treatment checks.

At first glance the number of checks recommended is intimidating. TG275 recommends a thorough and extensive check to help catch errors that occur; however, in a busy clinic, the practicality of such a check is in question. Understanding that clinical resources can be limited, the task group calls upon vendors to develop automation solutions to help address this need.

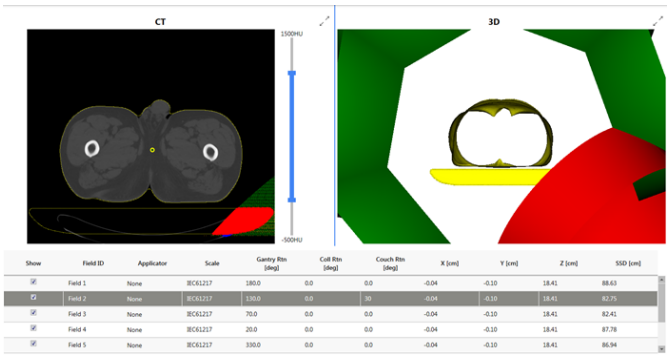
1. Pre-Treatment Checks

80+ plan checks are automated with Radformation's ClearCheck plan evaluation software. From structure checks to collision detection to prescription checks, ClearCheck reviews plans instantly in the Eclipse TPS through scripting. Over 500 clinics in North America are taking advantage of ClearCheck automated plan checks to increase the amount of checks that are completed in less time.

One plan check that has been particularly useful during the COVID-19 pandemic is CollisionCheck. With many treatment planners working remotely and alternating which days they are in the clinic, clinical staff does not always have access to machines to complete a dry run to test specific field arrangements. CollisionCheck offers a virtual dry-run checking for structure and HU-based collisions. Built into ClearCheck, the collision detection works for c-arm linear accelerators, electron cones, and SRS cones.

Default Plan Checks

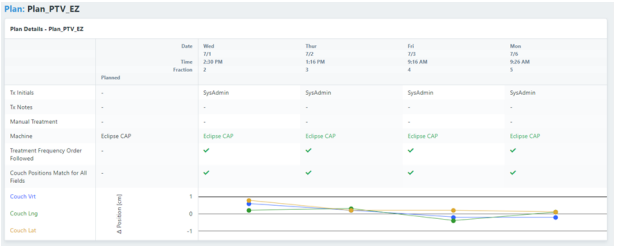
Plan Check	Expected	Prostate4	Pass/Fail
Photon Dose Calculation Algorithm	AAA_13623	AAA_15151	✗
Photon Volume Dose Grid Size (cm)	0.25	0.25	✓
Photon Heterogeneity	ON	ON	✓
CT Slice Thickness (cm)	0.25	0.5	✗
Maximum Number of CT Slices in 3D Image	≤ 250	52	✓
DVH Structure Dose Coverage (%)	≥ 100%	SKIN: 98.2%	✗
DVH Structure Sample Coverage (%)	≥ 100%	≥ 100%	✓
Minimum Field Size of X or Y Jaw (cm)	All Fields ≥ 3	All Fields ≥ 3	✓
Position of X or Y Jaw (cm)	All Fields Jaw Positions Rounded to Nearest 0.1	All Fields Jaw Rounded to Nearest 0.1	✓
Reference Points Have No Location	All Reference Points Have No Location	PTVHD: Has No Location PTV: x: -0.15 y: 3.94 z: 18.43 PTV1: Has No Location	✗
Support Structure (Couch) Inserted		CouchSurface CouchInterior CouchInterior1	△
Couch Support Structure(s) Inserted	Appropriate Couch Structure(s) Inserted	No Couch Support Structure(s) Needed	✗
Maximum MU Duty Cycle	≤ 5	3.21	✓
Gantry Angle IEC 180E or Varian 0E might be needed		Field 1: Check if Gantry Angle 180E Needed	△
Gantry Angles are Integers (deg)	All Fields are Integers	All Fields are Integers	✓
Collimator Angles are Integers (deg)	All Fields are Integers	All Fields are Integers	✓
Table Angles are Integers (deg)	All Fields are Integers	All Fields are Integers	✓



In addition to plan checks, ClearCheck also calculates dose constraints, automates treatment plan documentation, and evaluates plan sums and plan comparisons. From university hospitals to rural clinics, ClearCheck is flexible enough to work for different types of departments and can be customized based on your current Eclipse clinical protocols or templates.

2. On-Treatment Checks

35+ on-treatment plan checks are automated using ChartCheck software to increase the efficiency of weekly checks. Instead of checking on-treatment parameters once a week, ChartCheck runs 24/7 to ensure that when an error occurs it can be corrected immediately before additional treatments are delivered. Automation allows for constant monitoring of treatments which increases the safety and quality of patient care. Alerts sent directly to the clinician's inbox allow for customizable updates on when to take corrective action. ChartCheck also automatically bills to ensure charges are captured with the option of documentation to support the charge.

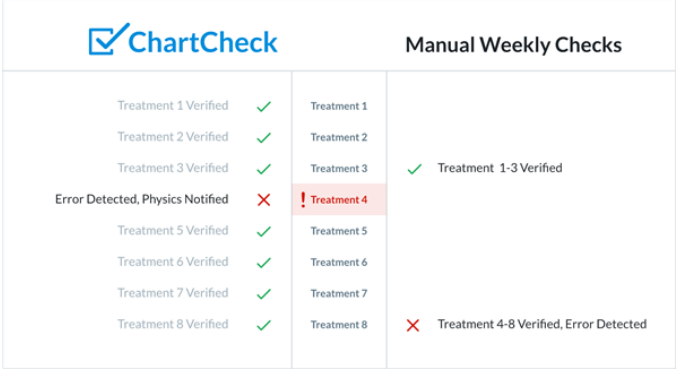


Radformation was founded by a team of physicists that wanted to bring user-friendly automation tools to clinics throughout the world to make clinicians' lives easier. As board-certified physicists working in the clinic, it was clear that many clinical tasks were a manual and tedious process that were prone to human error and inefficiencies.

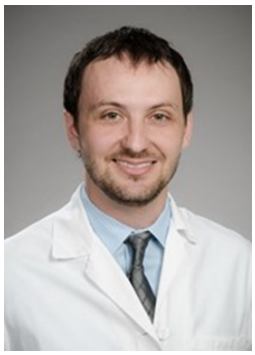
We stay committed to creating practical solutions rather than irrelevant products that sound nice in theory but create distractions and additional work. We are proud of our user-friendly tools that advance care. We strive to make it as easy and safe as possible for clinicians to give their patients the treatment and attention they deserve.

If you would like to learn more about Radformation and our automation tools, please contact us at info@radformation and visit our website www.radformation.com.

In addition to **ClearCheck** and **ChartCheck**, we offer other automation tools including **ClearCalc** automated independent calculation, **EZFluence** automated 3D planning, and **QuickCode** automated billing QA.



Total QA: an effective tool for managing and documenting Radiation Oncology imaging and treatment equipment QA



Ryan Price, PhD

Hui Zhao, PhD
NACMPA Member

Introduction of Total QA

Total QA is a system developed by Image Owl, which may be used for managing and documenting treatment equipment QA for radiation oncology. Total QA allows for the creation of QA templates using either preconfigured tests or customized tests you can design to fit your institution's workflows. These templates can then be scheduled for daily, monthly, annual or other routine QAs for all treatment machines and imaging systems, all with preset tolerances for each individual test that allow for quick pass/fail feedback. These are all recorded under the history of each machine allowing results to be reviewed and analyzed longitudinally, trends to be monitored, and QA reports to be generated with out of tolerance results flagged in the report. Additional to the managing and documenting of QA, Total QA has several other tools, including a Machine Log, TG-51 Worksheets, automated Image Analyses, an Incident Learning System (ILS), and a customizable equipment hub that allows the automated integration/upload of QA results from other equipment in the clinic.

Test Management and Scheduling

Total QA has many preconfigured tests designed to meet TG-142 and other standards, and allows QA templates to be created for your clinic using

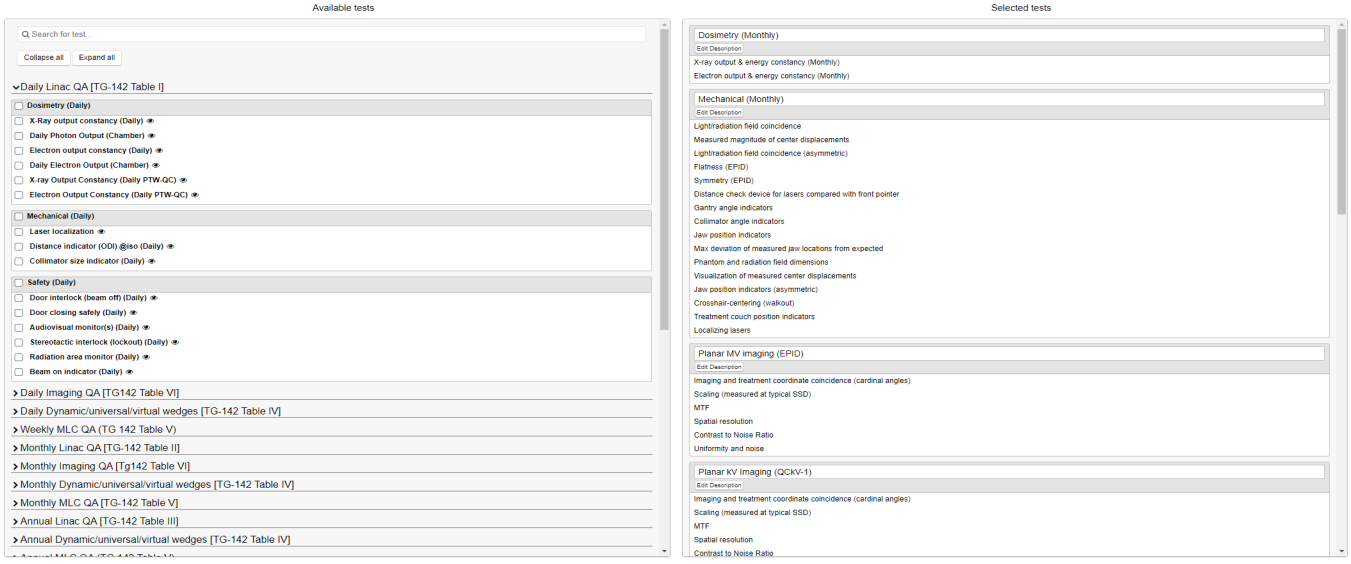


Figure 1. Some of available tests in the template creation screen

any combination of them. Currently, numerous tests exist specifically for QA of Linear Accelerators, onboard imaging, standalone imaging systems like CT and MRI, and Brachytherapy systems (see Figure 1). However, if none of the provided tests work for your clinic's needs, Total QA also has functionality for creating your own custom tests, as well as a template library where users can share their creations with each other.

Once the templates are created, management of the overall QA program is quite simple. Any available template can be scheduled for the relevant equipment and frequency, and assigned to the type of staff responsible (ie you can make only daily QA available to therapists, but everything available to physicists). As QA is completed and finalized, QA reports appear on the "Review" list for final approval (see Figure 2), making day-to-day management of QA much more convenient for physics.

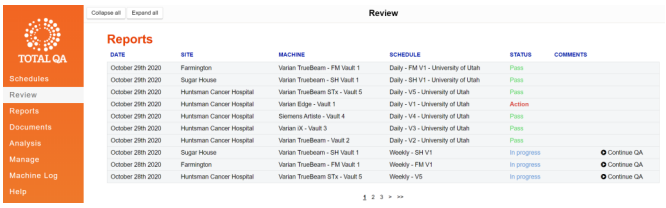


Figure 2. QA Reports as they appear for physics review

QA result Analysis and Longitudinal Tracking

One of the most powerful benefits of utilizing Total QA, is the easy longitudinal tracking and results analysis. Every test can be viewed and inspected for trending and systematic offsets with ease (see Figure 3), allowing for more informed decisions to be made when managing these technologies.

Additionally, Total QA has an analysis tab that allows for comparison of results between machines, and further investigation of results distributions (see Figure 4), elucidating any problems or differences in machine precision across the clinic.

Machine Log

In addition to the management of QA, Total QA has an optional tool for tracking machine down time and faults (see figure 6). This allows for better tracking and follow up of ongoing problems within the clinic, particularly for clinics that must continually hand off responsibility of these problems to the next covering clinical physicist. As an added benefit, this log can also serve as a database of solutions to common clinical problems, assuming the solutions are entered into the log upon closure of the ticket.

Incident Learning System (ILS)

An incident learning system (ILS) has also been in-

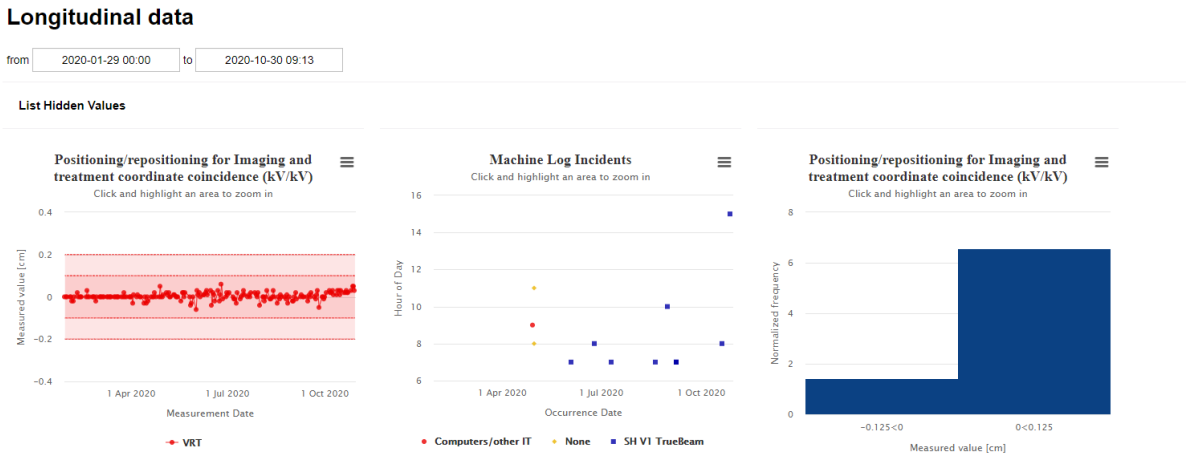


Figure 3. Longitudinal data for an imaging coordinate coincidence test, displayed with warning and action thresholds (left), machine log incidents during same time-frame (middle), and histogram of results (right)

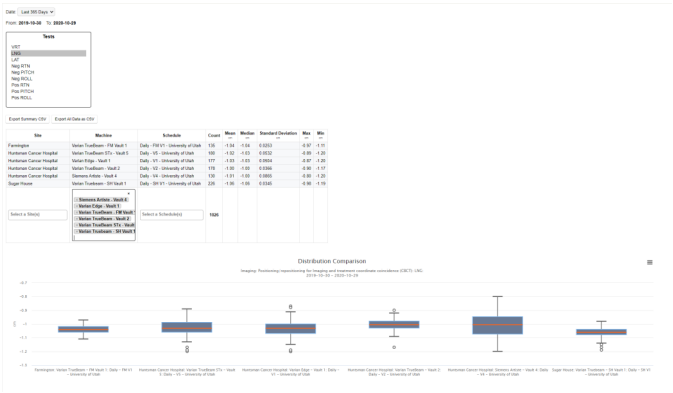


Figure 4. Analysis tool comparing daily shift accuracy QA results between machines.

corporated into Total QA. Safety committee members, custom tags, severity labels and hazard label may be created and configured in the ILS system. Custom tags may be created for categorizing the incidents, and for future data search and further analysis. Both severity and hazard labels may be custom created to fit individual treatment center's needs.

Utah's Total QA experience

Total QA has been clinically applied at the University of Utah since early 2020. Currently, all treatment machine's daily QA and weekly QA are managed and documented in Total QA, with monthly, imaging, and annual QA workflows currently being developed and in use on one machine. In addition to the benefits described above, we have generally been excited at the potential these tools have for helping us automate some of the more tedious tasks involved in a well-documented QA program. With access to the Total QA Application Program Interface (API), we have even been able to automate the importation of QA images into the software. The development team behind Total QA is always busy improving their tools, and as a result our use of these tool have grown exponentially in the last year. Figure 5 shows the current University of Utah Huntsman Cancer Hospital site equipment managed in Total QA. Also, machine Log has become the main and only managing, documenting and communication tool for all equipment problems and repair status at Huntsman Cancer Hospital, and our experience has been so positive that we have even begun testing its use at a ticket system for our IT department. Figure 6 shows current machine log for Huntsman Cancer Hospital.

As a summary, from our roughly 10 months of experience of Total QA at the University of Utah, the software can be an effective tool for managing and documenting radiation oncology imaging and treatment equipment QA. All equipment QA information is summarized in Total QA, and the results may be reviewed, reported, and further analyzed. Machine Log is an efficient managing, documenting, and communicating tool for handling equipment problems.

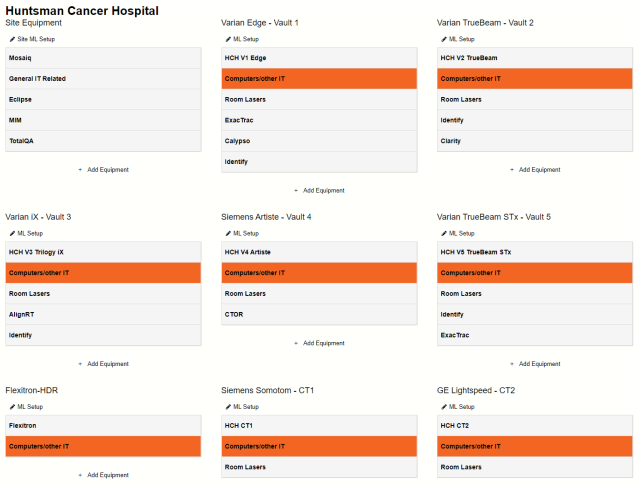


Figure 5. Huntsman Cancer Hospital site equipment in Total QA

Figure 6. Current machine log for Huntsman Cancer Hospital

DV.Target Auto-Contouring System 放疗自动勾画系统

Narisu Bai, DeepVoxel Inc.

DeepVoxel Inc.的自动勾画系统 DV.Target可以在CT图像中自动勾画50个危及器官。利用我们自主研发的深度学习算法，DV.Target可以显着提高放疗计划流程的准确性和效率。

DeepVoxel Inc.是一家位于加州Irvine的科技创业公司，我们致力于开发最先进的人工智能和深度学习解决方案，以应对医疗保健领域中的未解决的问题。通过与世界领先的医疗机构紧密合作，为复杂的临床工作提供技术方案以及应用。

DV.Target可以提高勾画质量并大幅减少放疗计划的时间。基于最新的深度学习算法，DV.Target可以在人体四个部位（头颈、胸、腹、盆腔）的CT图像中自动勾画出50个危及器官，准确率分别比人类专家和基于atlas的勾画方法高出10％和15％。 DV.Target仅需要3-4分钟即可勾画一个病人，而人类专家则大约需要1-2小时。DV.Target已部署在加州City of Hope 癌症医疗中心和南加州大学Norris癌症治疗中心。我们已向FDA提交了DV.Target的510(k) 申请，将会很快得到 FDA的许可。

DV.Target, an auto-contouring system developed by DeepVoxel Inc., can automatically delineate 50 organs-at-risk (OARs) directly from CT images. With our innovative deep learning algorithm, our automation workflow can significantly enhance accuracy and efficiency in radiation therapy planning process.

DeepVoxel Inc. is an Irvine, California based technology startup that is dedicated to developing state-of-the-art AI and deep learning solutions to challenging problems in healthcare. We work closely with leading healthcare institutions to provide applications that address the most intriguing clinical tasks.

Radiation therapy is one of the most widely used therapies for cancer treatment. A critical step in radiation therapy planning is to accurately delineate all OARs to minimize potential adverse effects to healthy surrounding organs. However, manually delineating OARs based on CT images is time-consuming and error-prone. Automated image contouring is showing improvements in efficiency for a number of clinical tasks in radiotherapy.

While atlas segmentation has proven moderately beneficial, the next generation of algorithms based on convolutional neural networks and deep learning is pointing to improvements in precision and efficiency. DeepVoxel Inc. developed a deep learning based auto-contouring system to delineate 50 OARs in four anatomic sites, significantly outperforming the individual human expert and the atlas-based method by 10% and 15%, respectively. DV.Target system takes only 3-4 mins to delineate an entire patient set, compared to around 1-2 hours by a human expert. These features demonstrate the benefits for using DV.Target to improve the quality and reduce the treatment planning time of radiation therapy.

DV.Target has been installed in the sites of our collaboration partners, City of Hope Cancer Center and USC Norris Cancer Center. We have filed the FDA 510(k) submission for DV.Target and waiting for the FDA clearance.

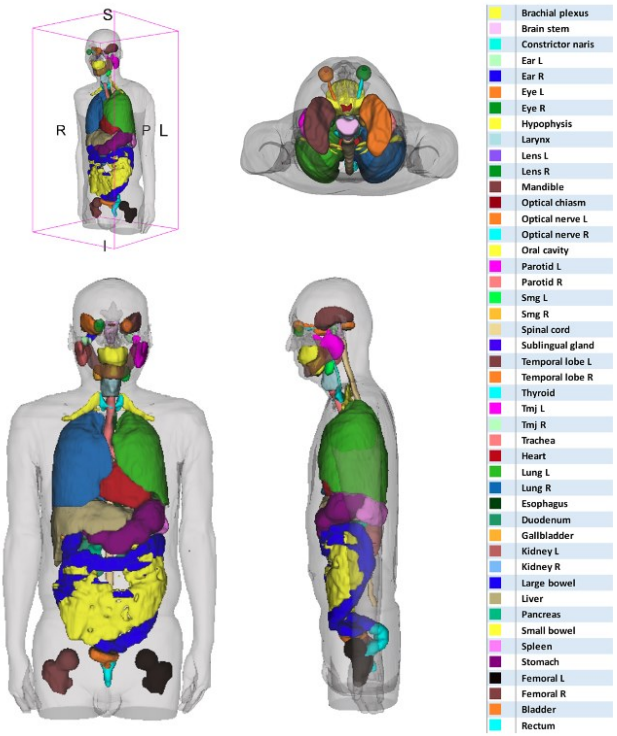


Figure 1. Illustration of the OARs delineated by DV.Target in the entire body. The views are from three different orientations.

OAR	MAS	U_s-Net	Human
Brachial plexus	30.38±15.63	**56.15±10.83**	33.03±7.83
Brain stem	82.25±7.47	**86.25±3.86**	83.25±4.63
Constrictor naris	66.38±8.21	**75.46±6.13**	62.34±8.63
Ear L	70.38±14.94	**77.28±4.25**	43.57±12.63
Ear R	70.03±15.57	78.64±6.35	39.71±10.81
Eye L	85.96±10.99	**92.51±2.00**	90.71±2.11
Eye R	82.68±17.38	**92.49±2.34**	91.51±1.79
Hypophysis	43.54±18.45	**63.86±8.73**	59.26±14.77
Larynx	82.60±8.19	**89.25±3.26**	68.60±6.59
Lens L	46.25±24.29	**81.90±6.88**	64.27±10.06
Lens R	45.53±23.94	**83.04±5.90**	71.79±9.59
Mandible	83.95±11.48	**93.12±1.41**	90.97±1.46
Optic chiasm	42.08±17.52	64.21±16.39	28.61±14.40
Optic nerve L	59.49±14.61	**75.73±7.26**	65.10±8.44
Optic nerve R	59.08±16.53	**76.06±6.49**	66.14±7.29
Oral cavity	86.10±9.11	**90.77±2.32**	79.30±3.59
Parotid L	72.52±15.57	**84.86±4.22**	78.46±4.90
Parotid R	71.20±17.55	**84.93±3.99**	78.88±4.41
SMG L	60.89±12.11	**80.71±7.32**	77.73±6.25
SMG R	63.70±15.80	**82.54±7.47**	74.10±16.92
Spinal cord	77.42±16.70	**85.64±5.90**	84.59±6.62
Sublingual gland	21.52±16.34	**45.99±18.84**	35.16±23.87
Temporal lobe L	80.05±7.28	**84.78±2.62**	82.41±5.01
Temporal lobe R	78.26±7.40	**84.13±3.34**	80.90±7.49
Thyroid	63.68±19.65	**85.62±4.63**	82.42±6.16
TMJ L	61.26±19.86	**87.96±3.12**	84.67±5.09
TMJ R	63.45±20.48	**86.86±3.60**	81.98±8.59
Trachea	65.86±18.75	81.29±4.84	**91.05±1.69**
Average	64.87	80.43	70.38

Figure 2. Dice similarity coefficient comparison for Head & Neck OARs, referenced from our publication in Nature Machine Intelligence [1]. MAS: Atlas-based method; U_s -Net: The algorithm of DV.Target for Head & Neck site; Human: Manual delineations produced by a human expert.

1. The key characteristics of technology in DV.Target auto-contouring system include:

1.1 Automatic delineation of 50 major OARs in four anatomic sites --- head-and-neck, thorax, abdomen, and pelvis, including most of clinically important OARs even the challenging small OARs such as the optic chiasm.

1.2 Accurate delineation result. DV.Target achieves an average Dice similarity coefficient of 84% (80% on Head & Neck OARs) across the 50 OARs on a totally independent clinical dataset, outperforming a popular atlas-based method by 15%. Compared to the individual human expert, the delineation performance of DV.Target still outperform by 10%.

1.3 Better delineation performance than other auto-contouring products. During the conduct of the validation studies for FDA clearance, we have demonstrated the superiority of DV.Targert performance compared to other auto-contouring products. In Figure-3, we illustrate the delineation results of ground truth, DV.Target, and a deep learning based product (the predicate used in our FDA validation studies). Clearly DV.Target performs better than the other product.

1.4 Significantly reducing the workload and saving the time for clinicians from manually delineation. It usually takes 3-4 mins for DV.Target system to delineate an entire patient set. Also the entire workflow is fully automated, DV.Target is running in the backend and clinicians do not even need to open the interface for their daily use.

1.5 Interacting with medical data acquisition flow (CT

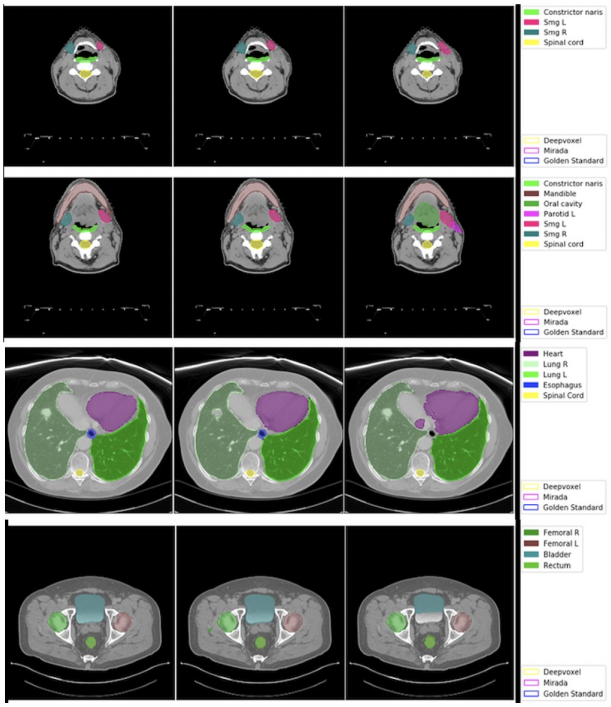


Figure 3. Visualization of delineation performance. Column 1: Ground truth annotations generated from the consensus of human experts; Column 2: Auto-contouring results by DV.Target; Column 3: Auto-contouring results by a FDA approved deep learning based product.

Scanners, PACS etc.) and TPS system with ease. The clinicians are able to review the contouring results in TPS directly without additional manipulation. Meanwhile, File Organization system and built-in delineation editor of DV.Target provide a clean and powerful user experience as well.

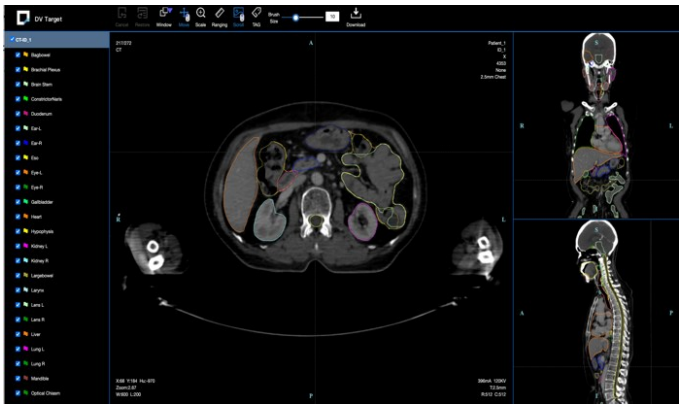


Figure 4 The visualization interface (Delineation Editor) of DV.Target.

1.6 The algorithms used in DV.Target and our state-of-the-art models have been published in *Nature Machine Intelligence* [1], as well as other top journals and conferences like *Medical Physics* [2], *AAPM* etc. Our research team, specialized in computer vision and deep learning fields, consists of highly skilled and experienced professionals. We keep iteratively upgrading our system and provide the best customized supports to our users.

2. The deployment of DV.Target.

DeepVoxel Inc. provides two deployment solutions of DV.Target to handle the requirements from different customers.

2.1.Standalone Software.

The standalone DV.Target software can be installed locally, within a local network with an existing hospital-grade IT system in place, on a specialized server supporting deep learning processing. In this way, the image data processed would be kept in the local network to ensure the data security and avoid the patient privacy leakage. Users can login to the DV.Target administration interface via browsers from their local computers. All activities, including auto-contouring, are operated by users through the administration interface.

The specialized server needs a Graphic Processing Unit (GPU) backed deep learning environment with certain additional hardware requirements. However, the customers do not need to worry about the setup since DeepVoxel Inc. will provide the corresponding qualified servers for the convenience of our customers.

2.2 Web-based Platform.

(https://irvine.deep-voxel.com/)

DeepVoxel Inc. also developed a web-based DV.Target platform, so the users can easily access remotely and start testing the algorithm immedi-

ately without worrying about the deployment. Currently the platform is open to the public with free research license. Users can upload the anonymized image data to the platform and check the auto-contouring result in our visualization interface right away. This platform is more like a testing application for the new users to get familiar with our algorithms and the system. It also demonstrates our confidence that the auto-contouring performance of DV.Target can be validated by the public.

All in all, deep learning based algorithm is a powerful tool and we believe it will change the future of radiation therapy. We would like to work closely with our collaboration partners and customers to provide sophisticated and comprehensive solutions. Empowered by our automated medical imaging analysis solution, DV.Target can help our customers significantly improve the quality and efficiency in radiation therapy planning process.

If you have any questions, or you are interested in our DV.Target auto-contouring system, please do not hesitate to contact us. DeepVoxel Inc.'s supporting team will respond to your feedback in a timely manner. Your opinion means a lot to us!

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2 Zhu, W., Huang, Y., Zeng, L., Chen, X., Liu, Y., Qian, Z., Du, N., Fan, W., Xie, X.: Anatomynet: Deep learning for fast and fully automated whole-volume segmentation of head and neck anatomy. Medical physics 46(2), 576–589 (2019)

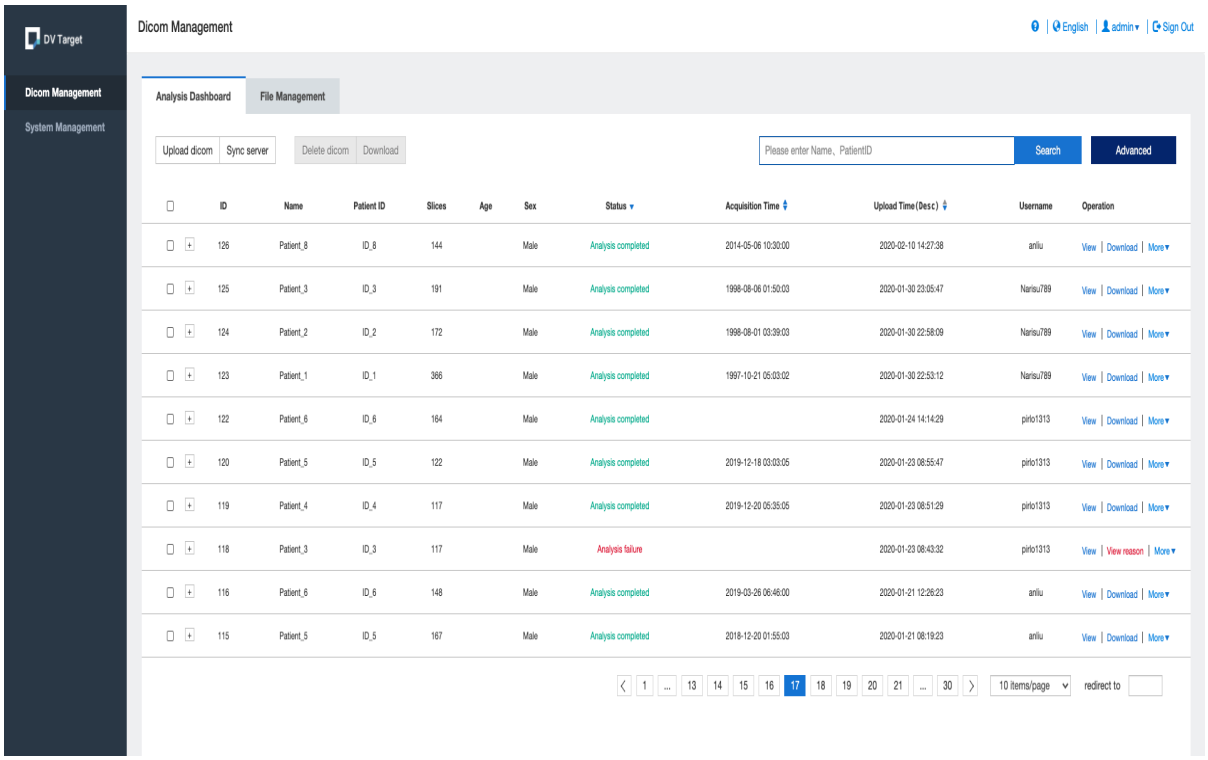
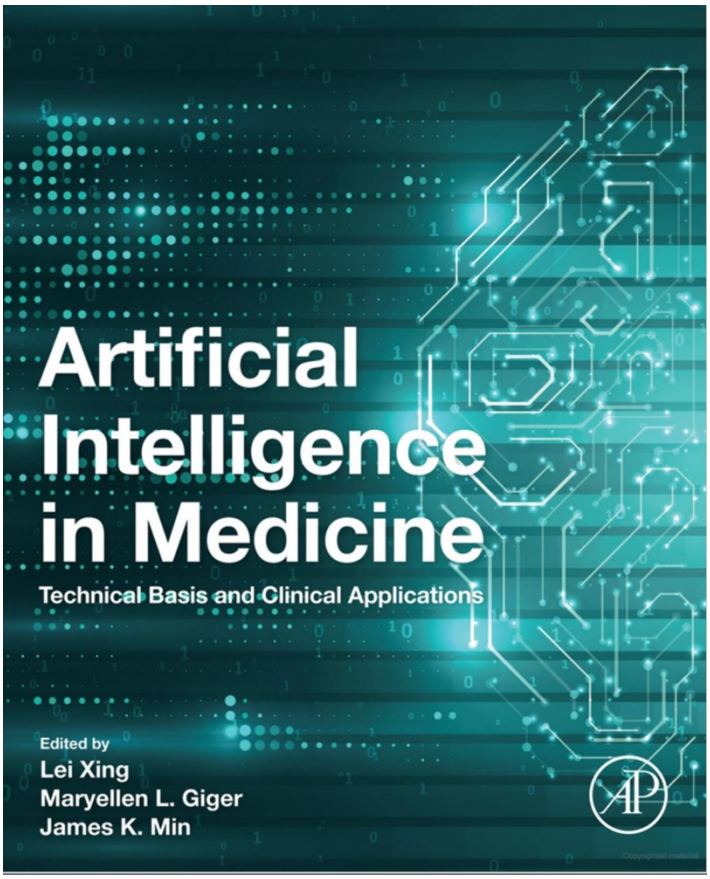


Figure 5. The administration interface of DV.Target web-based Platform.

Book Review: Artificial Intelligence in Medicine - Edited by Lei Xing, Maryellen Giger, and James Min

Dandan Zheng, PhD
NACMPA Member

The past decade has been a golden age for artificial intelligence (AI), with an explosive amount of research and development, evidenced by the transformative changes it is bringing to our everyday lives as well as its dominance at recent scientific conferences of many professions-especially medical physics. However, with the enormous promise of paradigm shifts AI could introduce into healthcare, it has yet to show revolutionary clinical benefits, indicating that we may be at the dawn of a new AI age in medicine. At this opportune time, a new book recently published by Elsevier in September 2020, *Artificial Intelligence in Medicine*, successfully filled the void of a comprehensive and authoritative writing on the topic with a 544-page fascinating read that details the state-of-the-art developments in various medical subfields. This excellent book was edited by three international champions of this field, Dr. Lei Xing (Jacob Haimson Professor of Medical Physics and Director of Medical Physics Division of Radiation Oncology Department at Stanford University), Dr. Maryellen Giger (A.N. Pritzker Professor and Vice-Chair for Basic Science Research in the Department of Radiology at University of Chicago), and Dr. James Min (the founder and CEO of Cleerly, Inc. and former Professor of Radiology at Weill Cornell Medical College), and contributed by more than four scores of known experts in the field such as Dr. Bradley Erickson, Dr. Ge Wang, Dr. Philippe Lambin, and Dr. Lily



Peng. The following article will provide a brief review of this informative and inspirational book.

自古以来，类人智慧的机器人一直是人类的终极梦想之一。最近十年又算得上是人工智能（AI）飞速发展的一个黄金时期，从阿尔法狗（Alpha Go），自动驾驶汽车到脑机交互，人工智能正以迅猛之势席卷整个人类社会。记得二十年前，笔者还在一个认知生理学实验室做毕业设计，实验室的一个主要课题就是在各种核磁共振功能图像的指导下构建新的算法提高电脑围棋的水平。而在当时，虽然在国际象棋上电脑已能击败顶尖人类棋手，在围棋上却连普通入门的小朋友都下不过。这是因为围棋的分支因子极多，诸如暴力搜索等传统人工智能方法很

难奏效，因此当时甚至有人认为在围棋上电脑不可能战胜人类。然而历史车轮滚滚向前，2015年末谷歌DeepMind开发的阿尔法狗击败世界顶尖围棋手，这场划时代的胜利次年见刊于《自然》。其制胜的一个关键就是近年来被研究运用得如火如荼的深度神经网络。在它的帮助下，电脑可以实现在千枝万岔的网络下的棋看N步，又能像人类大脑一样自发学习、直觉训练，对于在传统人工智能方法下曾经觉得不可战胜的复杂任务也逐一迎刃而解。这项近十年中异峰崛起、称霸江湖的深度学习（DL）是已有大半世纪历史的机器学习（ML）的一个子分支，利用大数据（BD）为燃料，它是目前 人工智能领域的生力军，推动着人工智能在机器视觉、指纹识别、人脸识别、专家系统、自动规划、自动驾驶等实际运用领域迅猛发展。

医学与人类生存息息相关，在医学上的发展和运用自然是人工智能领域很重要的一块。无论国家战略还是各大公司，医用人工智能都是大家竞相追逐的一个方向。医学物理是医学领域中技术性和创新性最强的学科。医学物理师作为医疗界的技术领跑者、工程师和应用程序员，很自然地站在了这片浪潮的最前端。其中领导Bio-X项目的斯坦福大学医学物理部主任邢磊教授和领导乳腺癌人工智能诊断项目的美国工程院院士、芝加哥大学放射学系副系主任Giger教授就是其中的佼佼者和元老（OG）。最近，由邢磊教授、Giger教授连同心血管成像专家James Min医生一起主编，Bradley Erickson, Ge Wang, Philippe Lambin, Lily Peng 等近百位业内熟知的专家共同攥写的《医学人工智能》（Artificial Intelligence in Medicine https://www.elsevier.com/books/artificial-intelligence-in-medicine/xing/978-0-12-821259-2）一书于今秋火热上线，为这个风起云涌的领域适时地贡献出一本综合全面、不可多得的好书。

本书目前仅出版英文版，比一般书籍大、较16K略小，一共25章、544页，分为四个部分：介绍(Introduction)、技术基础(Technical basis)、临床应用(Clinical applications)和未来展望(Future outlook)。介绍部分用两个章节简单回顾了领域的历史进程，综述了技术基础、临床应用以及章节作者的前瞻性见解。临床应用部分包含5个章节，分别讨论了生物医学录像数据（videos）的深度学习、图像分析深度学习、医用专家系统（expert systems）、分布式深度学习（distributed learning）和用于生物医学数据整合（data integration）的分析工具（analytics）。临床应用部分是本书篇幅重点，用300多页涵括15个章节，着重阐述了人工智能在医疗电子系统数据挖掘（electronic health record data mining）、健康调查大数据（wellness sensing）、智能手机（smart phone）应用、病理学（pathology）、消化内镜检（GI endoscopy）、眼底照相检测糖尿病（diabetic retinopathy）、放射学（radiology）、乳腺癌图像（breast cancer imaging）、泌尿科（urology）、精准癌症诊疗（personalized cancer management）、肿瘤学（oncology）、心血管成像（cardiovascular imaging）、神经科（clinical neurological conditions）、儿科（pediatrics）以及流行病学（public health surveillance）中的研究进展和应用。最后的未来展望部分用三个章节讨论了医学人工智能的社会人文因素（regulatory, social, ethical, and legal issues）、工业界视角和商机(industry perspectives and commercial opportunities)以及众编者的未来展望和挑战探讨。

本书最大的特点就是涵盖面的广泛和每领域里难得的专家见解。书中讨论的医学人工智能应用所依赖的医疗大数据涉及影像、录像、文字、声音、基因组、个人资料和临床检测等等（imaging, video, text, audio, genomics, demographics, and lab measurements），既有相关研究的最新进展汇编，又具作者编者的点睛之笔。相较于市面上类似主题的出版物，本书不似诸如《Deep Medicine》、

《Artificial Intelligence in Healthcare》、《Machine Learning and AI for Healthcare》这样以单一作者的视角主观介绍和片面讨论医学人工智能这个热门话题的通俗读物，而是一部由众多专家对广泛领域内最新进展的科学总结和观点阐述的专业书籍。跟《Big Data in Radiation Oncology》、《Radiomics and Radiogenomics》、《Machine Learning in Radiation Oncology》等类似专业书籍比较，本书除了传统医学物理领域外还涉猎了许多别的医学分支，着眼点全面，为有兴趣致力于医学人工智能的业内人士提供了一本综合学习的好读物、好教材。出版于今年九月，本书的内容相当的新。诚然，对于人工智能这个迅猛发展、日新月异的领域来说，一本书，甚至一篇学术论文出版的时候，就学术意义而言它可能就已经过时了。但就专业学习了解启发而言，本书是目前最好的选择，恰逢时机地提供了一本既全面又专业的好书。笔者作为一名临床放疗物理师，除了在专业内对深度学习、分布学习、癌症诊疗决策等方面获益良多，有更深刻的认识之外，在读到像智能手机应用软件（using smart phone sensors, camera, GPS, and other mobile functions for decision support and health promotion）、流行病应用（public health surveillance）等章节时也惊喜颇多。其中人工智能在其它医学领域的应用和诸如商业机会和挑战、创新到市场运用周期的工业界视角也给人启发。他山之石，可以攻玉，无论读者的学术领域是其中哪一个方向，除了在术业内得到学习提高之外，相信都能从这本综合全面的新书中找到一些意想不到的启迪。

本书引言由两位斯坦福大学教授、医生学者，生物医学信息学专家Curtis Langlotz和分子成像专家、放射系前系主任Sanjiv Gambhir所著，相当精彩。如他们所说，人工智能具备下一场工业革命的潜力，却还尚未展示出显著临床效用（AI is a potentially revolutionary technology that has yet to show significant practical clinical benefits）。这一切昭示，我们正站在医学人工智能破晓之时（we are still at the dawn of AI and its effect on clinical radiology practice）。本书适逢其会，由业内专家精心撰写、顶尖大咖用心编辑，以其丰富、权威、时新的内容，襄助读者迅速学习了解医学人工智能，在这场风起云涌的划时代运动中乘风破浪。