Science AMA Series: Hi, I'm Dr. John Adler, inventor of the CyberKnife, Founder and Editor-in-Chief of the Cureus Journal of Medical Science and Professor of Neurosurgery at Stanford University. Ask me anything!

John$_{A}dler^{1}andr/ScienceAMAs^{1}$

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Abstract

Hi reddit! Since 1987 I have been an academic neurosurgeon at Stanford University. During my professional career I also invented the CyberKnife, and in doing so, the field of image-guided radiation. To date the CyberKnife has been used to treat more than one million patients, and derivative technologies have treated millions more. During my years in academia and the medical device industry I have come to appreciate the importance and power of peer-reviewed journals in guiding the practice of healthcare worldwide. From my own experience and frustration with the medical publishing process, I recently co-founded a next generation Open Access medical journal called Cureus. Peer-reviewed journals are an essential element of the bedrock underlying scientific progress. However, publishing in traditional journals has long been a time-consuming, complex and costly process. Although an unpaid workforce of highly skilled authors and reviewers does the hardest work in medical publishing, very expensive subscription fees typically limit the scope of readership. The alternative Open Access publishing system requires authors, many of whom lack significant research funding, to "pay to play." Tragically, so many financial and procedural barriers are preventing the widespread generation and dissemination of medical knowledge, which as a point of fact, can be life saving in many cases. To my way of thinking something is very wrong with this existing system; access to advanced medical knowledge can and should be a human right! With this objective in mind, Cureus aspires to disrupt the status quo by making both the publishing and reading of quality peer-reviewed journal articles free, and thereby opening up the floodgates of medical knowledge to all of humanity. Now that you know what I'm up to, I turn the floor over to you - ask me anything about neurosurgery, Cureus, the CyberKnife, medical publishing or anything else that you can think of. I'll be back at 1 pm EST to answer your questions. Bring it on!

the WINNOWER

REDDIT

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JOHN_ADLER R/SCIENCE

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No questions for you. Just came here to give my thanks. My mother had brain tumors (chordomas). CyberKnife added years to her life. I believe she actually went to Stanford for her first treatment.

JaySuds

That's great - thanks for the words of encouragement and glad to hear that it made a difference.

What was your role as the inventor of the cyberknife? How many physicists, engineers, basic scientists, etc.were involved in the process. Where did the concept originate?

porkly1

CyberKnife, Founder and Editor-in-Chief of the Cureus Journal of Medical Science and Professor of Neurosurgery at Stanford University. Ask me anything!, *The Winnower* 4:e149942.28257 , 2017 , DOI: 10.15200/winn.149942.28257

The basic concept originated with me and was embodied in a patent that was issued in the early 1990s. Subsequently, this project involved a sizable community of engineers and physicists - I'd say it required about 25 engineers to develop the first prototype.

What are your thoughts on Valery Spiridonov, the man that's to have a head transplant? In the unlikely event of its success, do you believe it could pave the way in new treatments for terminal neurological disease or permanent paralysis?

PM_ME_FRESH_PRODUCE

I don't consider any procedure that leaves the patient in a perpetually immobile state of existence as much of a breakthrough. Until we're able to get nerves to regenerate significantly, procedures like this are little more than surgical freak shows.

I was told, in a recent lecture, that there would be three types of medical jobs in the future: those programing robots, those maintaining robots, and those taking orders from robots. To some extent, this was a joke about technology and automation in medicine. However, as the inventor of CyberKnife, does that sound like a realistic possibility to you? To what extent is the human element realistically replaceable?

Follow up question, if I may? I am profoundly interested in the prospects of open access to academic literature, but I've heard many in the field dismiss open-access plans for reasons including lack of funding, and lack of trust in non-traditional operations. May I ask how Cureus will overcome these issues?

Wodnescild

Ha! Robots will have an immense future role throughout surgery, no doubt about it. However, I am less convinced that A.I. will in the short-term have as big an impact throughout medicine as its measure proponents are suggesting these days.

In terms of Cureus, internet technologies have paved the way to introduce new processes for developing trust among disparate individuals. Cureus has done its best to incorporate these concepts into its design. Look, Open Access is inevitably the future of academic publishing, but to break down the last barriers is going to require a more efficient, lower cost option. And that is what Cureus aspires to be.

Thanks for coming here for an AMA! I have a couple questions about each of your projects.

What inspired you when creating Cyberknife? How does the Cyberknife deliver radiation to a 3D space with linear delivery by a beam of radiation? Is there a second source with a radiation maximum at the intersection?

What is the review process for Cureus? Does the journal lean toward any type of medicine or is it open to surgery, medicine, therapy, etc? Recently the evidence based practice world had a lot to say about not publishing negative results in many journals. What will the stance be for publishing negative results in Cureus?

815414

Thanks for the question! My ambition was to make surgery less invasive and more effective. It would take me all day to adequately explain how the CyberKnife does what it does. Read our articles in

Cureus on the CyberKnife to learn all the ins and outs - going back to an earlier question, this demonstrates the importance and value of Open Access publishing.

The review process is single-blind and completed entirely online. We just developed a new interface that works in a similar manner to making comments in MS Word. Cureus welcomes all medical disciplines, but we greater penetration in procedural specialties.

The failure to publish negative results is emblematic of the problems with traditional medical journal publishing which is obsessed with status. In contrast, Cureus has a post-publication review system (called SIQ) that allows our journal to publish more liberally the negative studies which generally speaking have a smaller readership.

Had a couple of doses of steriotactic radiotherapy from a Gamma knife on a rather large AVM in my head, in conjunction w/ about 6 internal embolizations. They obliterated it over the course of 3-4 years, but when I woke up from the last embolization, my left arm had basically quit working. Ugh. How would the damage from the radiation over time, assuming it's even possible, impact the brain's capacity for neural plasticity necessary to rewire the damaged nerve connections? I can raise my arm after 2.5 years of therapy, but still can't get my hand to work. On a scale of 1-10 (surely the go-to metric in neurosurgery), how likely would you estimate is it that my cortex is screwed to the point that it can't rewire itself in that particular area? Only Cost me an arm and a leg, literally!

gonzotheape

Oh boy, I'm sorry to hear about your predicament. You are correct that it your brain is unlikely to repair itself and I since you insist, I'd give a score of 8. Good luck!

Good morning Dr Adler,

First off, I want to thank you with all of my heart.

Thanks to your invention my mother was able to live a longer life while fighting multiple benign meningiomas for over 20 years. This very technology helped her live long enough to go on a cruise (first vacation since getting diagnosed in 1994) and see me get married. Here she is on the cruise with me (my dad and fiance were there too). http://imgur.com/a/Tdjvm

We lost her 2 years ago this coming September. Your work, and countless doctors and nurses, let me have my mom through my childhood and into my adult life.

As a fellow scientist, in Pharma for over 10 years, my question is:

What did it feel like when you first saw your machine working to help a patient?

Thank you for everything you do.

Sevreth

Wow, thanks for the kind words. So happy to hear it. Wishing you and your family much love.

What made you call it the Cyber Knife and can you go into a little more detail on its medical uses today?

AashyLarry

The word "knife" emphasizes the surgical applications at hand and when I chose to use the word "cyber" it was long before the word "cyberspace" existed and it seemed like a cool and hip expression of the future. And apparently, the term worked.

Thank you for taking part in an AMA.

With respect to Cureus, will the reference limit imposed on submissions (Review articles: 50 references, Original articles: 30 references, Technical reports: 20 references, Case reports: 10 references, Editorials: 5 references) be lifted as the journal grows?

On a different note, as an accomplished professor, what activities would you recommend an eager medical student to engage in to help when applying for neurosurgical training programs down the line?

P-whiz

The reference limit is in place for a few reasons, chief among them is our size relative to the increasing number of submissions we receive. As a journal that doesn't charge for publication, we need to keep our editorial overhead down and reference-checking is an expensive part of publishing.

The reference limit reinforces the efficiency of using articles as a communication tool. Rarely do large numbers of references help the reader. This very decision highlights the unique aspects of Cureus, which aspires to the most efficient yet legitimate (and accessible) form of medical publishing.

Hello Dr.Adler; my wife (32 y/o, from UK) has undergone two craniotomies this year to remove a grade 2 astrocytoma from the right front lobe. We believe this has been successful and now expect regular monitoring through MRI, but hold hope that it will be some time before we have to face another tumour.

If you you able to sum up briefly, what significant advances are expected in the next 5/10/15 years that will have a real impact on the treatment of patients with tumours, such as my wife's?

whit123

Unfortunately, radiosurgery is unlikely to have much of an impact on a disease like astrocytoma because it is so diffuse. The good news is that there are important new chemotherapies that may address the problem in time.

What is your most important accomplishment? Science or Personal achievement?

chocolatemilk67

Neither of my kids are in jail.

Hi there!

Firstly, very cool tool. Preface: I am a microbiologist/mass spectrometrist.

I am wondering a) if you were aware of it and b) if so whether it could be used in tandem: I was at a talk recently where a surgeon from Britain had been using a ionising surgery knife (user operated) which profiled the lipid structure of ionised tissue to give a 95% CI of whether tissue was cancerous or not.

Would your technology be able to work in tandem with such methods of rapid screening to irradiate target tissue? How do you currently map areas for irradiation to your surgical robot? Is it guided by CT or some other form of imaging?

Thanks!

BucketChemist

Cool idea but I honestly have no idea at present. Worth following up on though!

I had a brain tumor treated using Cyberknife a few years ago. During the diagnosis phase I met with radiologists and neurosurgeons. The neurosurgeons advised open brain surfery, the radiologists advised Cyberknife. I understand that for certain tumors open surgery is required, but I was not one of those cases. I was very confused about my options because I couldn't understand why one doctor would advise something as extreme adn risky as open brain surgery, when there was a much less risky alternative.

My question is, why the great disparity in the suggested treatment?

Mightbehittingonyou

The devil's in the details, but generally speaking the bigger the tumor, and the safer the location in the brain, the more useful conventional surgery. Meanwhile, the smaller the tumor, and the more critical location in the brain, the more radiosurgery/CyberKnife is indicated.

I'm puzzled that you invented the Cyberknife, but now you work with Varian, a competitor to Cyberknife. Do you have reduced confidence in the Cyberknife these days?

TigerB65

No, I have every bit of confidence in CyberKnife. It remains the best tool for precision radiation, but stay tuned for my next act!

The treatment regimens for prostate cancer are shorter for the CyberKnife than other methodologies.

What data is there to suggest that this is comparable to outcomes of traditional radiation therapy?

This is particularly interesting with regards to earlier stage prostate cancers where recent multi-center data suggest that prostatectomy and radiation can be equivalent in terms of outcome (with radiation trending towards better), but with variations in the side effect profiles.

Thank you and great work!

dsm2927

Check out this article in Cureus for more info, specifically the references.

I fervently believe that the evidence supports short courses of (hypofractionated) radiosurgery are the equivalent of, if not superior to, conventional radiotherapy.

The problem we face is that the radiation oncology industry makes more money by delivering conventional radiotherapy than it can make with radiosurgery and this represents a serious headwind to the wider adoption of radiosurgical techniques.

Unfortunately, even in medicine it is necessary to follow the money sometimes.

Hi thanks for the AMA! I have 2 questions:

As a neurosurgeon at Stanford, what were some of your hardest cases?

Ben Carson is the secretary of the HUD, and is supposedly a prolific neurosurgeon, what do you think of him?

jake354k12

My hardest cases would be the many patients I failed. As for Dr. Carson, he's a great pediatric neurosurgeon who has been a good friend to me at times.

Hey John! I worked at Accuray 97-01! Those were exciting times, and I am proud of my small part. It was powerful motivation when you brought in patients who's lives had been dramatically improved using the Cyberknife. When I was there, it seemed like a huge obstacle in getting Cyberknive's in hospitals was that Neurosurgeons really preferred a craniotomy to stereotactic radiosurgery, because it was their talent that saved patients through surgery, rather than the technology through radiosurgery. Is that still a big problem or is adoption easier now?

threemuch63

I would say that the drama of neurosurgery is a huge attraction for neurosurgeons and it is hard to give up the adrenaline rush. No matter, radiosurgery is now the most common operation for brain tumors today, which is testament to just what a good procedure it is.

Young researcher here. I agree that current systems for peer reviewed articles are fucked. Besides all the usual issues there is also the issue of journals charging ridiculous fees just to publish a paper. This has been a common problem in india where students often must publish a paper to graduate. They submit them to junk journals and pay money to have it published.

With the advent of junk journals and articles how would Cureus prevent authors from flooding the portal with low effort articles?

_neutral_person

As long as an article contains legitimate medical science, we are committed to publishing it. We believe our SIQ system (our post-pub review system) is the best way for readers to discern article quality.

But in the end, it's important to understand many times one man's junk is another man's treasure. When you have deep interest in a narrow domain, oftentimes even rare but trivial findings are important.

How much of the invention of the cyber knife were you involved in? Were you involved in every piece of the process of was some of it beyond your control?

90059bethezip

In the earlier stages, I was involved with everything. However, I was blessed to work with a lot of smart

engineers and physicists.

Thank you for helping to contribute to society and attempting to do it on what could even be a more grand scale with your new project, it sounds amazing.

I guess I need a question...

What do you think is one of the most important medical information/study publicized in these journals that isn't getting a wide enough reach to the medical or overall community ?

retrofuturenyc

This is a good opportunity to talk about one of my passions: the need for more "small science" in the medical literature. The vast majority of journals look down at small case series as being inconsequential anecdotes, however, such articles almost always contain important nuggets of truth and in aggregate, represent a treasure trove of medical knowledge.

Imagine for a second that there existed a repository of literally hundreds of millions of validated, peer-reviewed clinical vignettes. One could draw upon this resource to answer literally almost any new medical problem that one encountered. This is the potential power of Cureus.

I saw the title of your AMA and just wanted to stop in and say thank you! My mom was diagnosed with Gastric Cancer 5 weeks ago. After finishing a couple of MRIs, they were able to determine that it was localized and completely treatable. Because of this, she will begin the CyberKnife treatment in 2 weeks and we are all thankful for your procedure and really excited that this is going to go so well. The device is amazing and truly a 21st century life saving technique.

God Bless you and the amazing technology you've brought to this world!

Gortanis

Thank you! So happy to hear it!

Thankyou for this AMA. If i can ask, what has been the response to you offering the new service Cureus, from other professionals and organisations who may support the existing pay and play system and be reluctant to support a free system ? Have you had much hostility? I would of thought as you that having a free and open publishing system would be good for all.

Wagamaga

This reminds me of the Gandhi quote (and I'm paraphrasing here so don't kill me if it's slightly inaccurate), "First they ignore you, then they laugh at you, then they fight you and then you win."

So it is true at present that we're starting to enter a period of mild hostility from the rich and entitled old guard of publishing who are intent on preserving the status quo. Viva la revolucion!

Thanks for your time. What will be Cureus business model? Will it be like PLOS ONE?

eddie_00p

Well, PLOS ONE has only a subset of medicine. It's a broader scientific journal. Cureus believes that its focus in medicine presents a unique opportunity for funding that isn't available to broader scientific

journals.

In particular, our highly clinical focus can be a communication resource between the broader physician community and the life science industry. Cureus has built the appropriate firewalls to preserve the integrity of this interaction.

In addition, we work with medical institutions, hospitals, and medical societies to provide a branded medical journal publication that enables them to demonstrate their clinical competencies and build their institutional brand.

What made you realise the need the cyberknife's creation? Would you have any advice for young surgeons aspiring to contribute to innovative changes in their field?

Additionally, did you know/train Paul Kalanithi? Have you read his book? And if so what did you think of his portrayal of the life of a resident neurosurgeon?

RedditName12

I saw too many patients suffer from both cancer and the surgery we once used to treat their cancer. I believed there had to be a better way and that a less invasive procedure would have an important role to play. I was lucky early in my career to work with Professor Leksell in Stockholm, who provided the inspiration for me to go on and develop the CyberKnife.

Re: advice - become a fully-trained surgeon and learn your craft well. Before you can make meaningful improvements in the field, it is important to have the deepest domain knowledge possible.

Yes, I knew Paul well and we collaborated on a few academic projects together. I also served as a mentor to him. Yes, I've read most of his book, and I think he did a credible job of portraying the life of a neurosurgical resident.

Hi Dr. Adler! Thanks for doing this. As an incoming MS1, I was wondering if you could talk about how/when in your medical education you decided/realized neurosurgery was for you. Did you know in undergrad? Beginning, middle, or end of medical school? Do you have any advice for medical students on what criteria to use to pick a specialty? A lot of the fields I'm interested in, like neurosurgery, are intensely competitive to match into-- so the earlier one can discover their interest the better. It's just so difficult when so many specialties overlap, have their own unique pros and cons, and above all, are incredibly interesting!

Seraphenrir

I chose late in my career. I was a first year resident in general surgery when I made the decision to specialize in neurosurgery.

Why did you want to become a doctor? Also, more specifically, what drew you to specialise in neurosurgery? Would you recommend this field to medical students?

I'm currently a pre-med student (studying in Australia). I'm hoping to get into medicine, and while I have my own motivations for wanting to do so, I'm always interested to hear what initially motivated doctors I meet to study medicine.

Thanks for the AMA!

Krakyn

Neurosurgery is great, but it is as much a calling life as it is a profession. It is an intellectually and physically demanding avocation with the power to dramatically impact human life. What more could you ask for in life?

Do you have a "worst student" that still gives you nightmares?

illyafromuncle

One of my worst residents went on to a extremely successful tech career. (I'm talking one of the first employees at a very large company you've heard of.) He found his calling.

Did you know Michael Lim tells all his patients he trained with the inventor of the CyberKnife but he never mentions you by name?

tealgreen

Well, shame on him! Ha! What does he say about Ben Carson?

Do you think that more open-sourced journals will lead to better informed doctors? How do you think we can address the issue of physicians who are not research-minded and not keeping up with the literature?

What were some of the factors that paved the way for you to invent the CyberKnife?

MtGroovius

There's too much information that isn't directly relevant. So let's do a thought experiment - a patient comes into your clinic with an unusual medical problem and they want to understand prognosis.

At present, you're forced to rely on a literature that blends the case stories of literally hundreds/thousands of patients that *may* have had a similar diagnosis, but a broad spectrum of confounding variables. Wouldn't it be sweet to find a near exact duplicate case (or several cases) for the patient that sits in your clinical at this very moment? Then you really could nail a prognosis.

A lot of hospitals buy new equipment to attract skilled personell interested in trying new pieces of equipment.

From an outsiders perspective, it seems like a lot of it is driven by doctors "vanity" and gadget-interest, more than an actual need in a clinical setting.

In countries where these costs come from taxpayers money it seems prudent to assess the actual added value from these items. Do you know of any research done on this, and is it something you try to quantize for your own product(s)? What should public hospitals be aware of when balancing the need to attract skilled personell, and spending taxpayers money in a responsible matter?

Dam0cles

I'd say you've raised good questions here and there is no simple answer, however, it is worth reminding ourselves that technologies that once seemed to be physician vanity projects have

profoundly impacted human health over the last generation.

For example, when CT was first invented, it was seen as an extravagant (almost vanity) and extremely expensive technology even at the biggest medical centers. Yet today even in some of the poorest countries in the world, CT scanners are seen as necessities.

Dr. Adler, my father is a Stage 4 lung cancer patient who's primary site was fully removed via a lobectomy. The cancer, as lung cancer often does, metastasized in the brain. Because of the blood-brain barrier, chemo was not a primary treatment and cyber knife came to the rescue. Because of CyberKnife, my dad has so far experienced 3 years of a great quality of life with hopefully many more to come, so thank you for your amazing invention! 2 tumors so far have been treated this way, with the 1st original tumor found was surgically removed and tested as lung cancer.

The limits (if I understand my dad's Doctors correctly) that we are finding right now are on the imaging and targeting of tumors with approx 1 cm being a sweet spot for both - smaller targets are too hard to see clearly on MRI/CT and I believe CyberKnife must have limitations too with how small a target it can hit without impinging on healthy brain matter.
So - my question is - do you think there is a path for the technology to improve in both correctly identifying tumors sooner and in the CyberKnife's minimum target size?

My second question is public policy related - My father is being treated in Canada, and we are fortunate to live in an area of Canada with good access to great healthcare. His treatment is fully paid for by taxpayers so we share the benefits and burdens of health costs in Canada - and feel privileged to do so.

In the US one of the fears of publicly funded healthcare is if governments fund healthcare the thought is that innovation will not happen. Do you think we can get the best of both worlds, from your position of a creator of new healthcare technology? Can we support innovation and have public healthcare in the US?

Thirdway

It's possible to treat tumors much smaller than a centimeter and we routinely use the CyberKnife to treat brain tumors that are only a few millimeters in size. I'm sure that in the years to come things will only get better.

Public healthcare systems are always going to be confronted with the need to ration healthcare at some level and unfortunately one of the first things to be sacrificed is innovation. So yes, I think there is a contradiction between government-funded healthcare systems and innovation.

No matter, it's important that society provide medical care for the less privileged. So for me, I believe we need a healthcare system that ensures everybody (all citizens) have a basic level of healthcare, but still leaves open the possibility for those who wish to pay more to have access to the most innovative (some of which are unproven) technologies.

No questions, just thanks for being a badass. My old man had a hemorrhagic stroke a while back, and found out he had an arteriovenous malformation. CyberKnife-like technology is apparently the absolute go-to for certain circumstances of this.

andybmcc

Good stuff! And I'm far from a badass, just ask my kids!

Hello! I have no question, but I just want to say Thankyou for the CyberKnife! I am a radiation therapist, and I have had the pleasure of using one of these in London, and they are amazing! The accuracy and homogeneity opens up so many new pathways for radiation oncology and helps us treat benign tumours and ones that are difficult with EBRT. Not to mention the reduction in morbidity and fractionation.

Again, Thankyou!

-Mamihlapinatapei-

Thanks for the kind words and your hard work!

Hi Dr. Adler! I don't have any questions but I did want to tell you that you're one of the reasons my little pupper is still alive. I have a seven year old Welsh Corgi named Kooper. Last year he had a bump on his nose and started sneezing up blood. After numerous trips to the vet., we were referred to CSU (which is only about an hour away) and little Koop was diagnosed with Adenocarcinoma. My wife and I were heart broken but we were in a position to provide whatever was needed for treatment. The gold standard was SRT.

Long story short, Kooper is in full remission! The tumor shrunk down by 90%.

I wanted to personally thank you for everything you've done. If this treatment wasn't available, we would have to use the traditional approach which could have made him sick and might not have been as effective in treating his cancer.

I_am_trying_to_work

Yay! That's wonderful to hear. Give Kooper my best!

Hello sir,

Your invention helped to save my dad's life. When he was diagnosed with a severe AVM in his brain which caused a series of aneurysms, the CyberKnife (combined with embolization) successfully shrunk it to a manageable size and prevented any further aneurysms.

10 years later he's still here with no lasting neurological damage.

Thank you for that!

(I need a question in here or this will be automatically deleted, so how's the weather where you're at?)

torgis30

That's amazing to hear! And it's a beautiful day in San Francisco!