I was fishing yesterday, and George called to see if my slides were ready for my talk today...

Cupertino was my home town: In 1975, I was a Junior in High School. Steve Jobs and Steve Wozniak were inventing Apple in Job’s garage, a few miles from our house. I was surrounded by tech innovators.

I found my one true thing.
Training to become a cardiac surgeon is a rigorous exercise in accessing information, and adopting new technology.

- In college and Medical School, from 1976 to 1984, I had an electric typewriter and a TI calculator.
- Things changed during my residency. In 1990, the Motorola Brick sold for 4,000 dollars, and the battery lasted 30 minutes. This was my first experience with the enormous value of having on demand access to information.

Advances in surgical imaging technology began during my residency. We took orthopedic endoscopic instruments, and created VATS: Video-assisted Thoracoscopic Surgery.

- We tried it on piglets in the lab, and it worked.
- We gradually extended the imaging technology to all of our heart operations.

In 1995, I moved from Boston to Miami. The first team members I met were Jorge Ojito, the perfusionist and Francisco Alonso, the OR tech. We decided to take a Silicon Valley approach to our new heart program. We would develop information systems to improve our performance.

Miami in 1995, had an information network based on the gold standard for medical information exchange:
Our office had paper charts and a typewriter, no computers.

1995: Information technology took off

• Larry Page and Sergey Brin meet at Stanford. (Larry, 22, a U. Michigan grad, is considering the school; Sergey, 21, is assigned to show him around.)
• According to some accounts, they disagree about everything during this first meeting.

Our system would have to integrate massive volumes of data in diverse formats from isolated islands of information.

• Handwritten Notes
• Teleconferencing
• E-mail
• Reference Materials
• Databases: Cardioaccess
• Patient Monitors
• Angiography and Echocardiography Studies
• MRI
• Operative images and video

How do you bring Silicon Valley to your heart program?

• In 1996, we incorporated a technology expert into the cardiac team. You need to have “an IT guy”.
• We encouraged him to share the team’s philosophy and goals, and to push technology to achieve them.
1997: We designed our Web based EMR around text and images, not tabs.

1999: Clinical images were taken daily, to convey the arc of recovery in a powerful way.

Routine daily patient images
- Images are taken with the goal of showing the child’s current condition
- All images are stored in our EMR.

Using operative and patient images for patient and family education. First stage Palliation for HLHS
What is the cumulative lifetime trauma of a congenital heart defect?

Second Stage Palliation at 3 months of age

Postoperative recovery after Stage 3 Fontan Procedure. Cumulative Trauma: 34 days.
We gave families access to these images.

- Adoption rate: 98%
- Patients log in while they are hospitalized
- Parents continued to log in after their child died—this was sometimes their last connection to their child.

1999: Back home in Silicon Valley…

- Nokia 3210 most popular phone, picture messaging
- Google founders Larry Page and Sergei Brin outgrew their garage office and moved to Palo Alto with eight employees.

In 2000, we went live with a Web based EMR

- In 2001, only 40% of physicians used the internet to access health information
- At that time, we had on demand access to all patient information on any web enabled device.

We used information tech to enhance our teamwork.

Published in 2004

We started playing Counterstrike on the PC, and Halo on Xbox One in 2001.
Video from a moving vehicle in the mountains outside Tokyo, Japan in July, 2002. Five years before the first I-Phone is released.

Video by Jorge Ojito, Chief of Perfusion Services, Nicklaus Children’s Hospital

2004: How can we turn surgical information into knowledge.

- Families always asked “How many have you done?” and “What are your outcomes.”
- We often asked the same questions of ourselves during our patient care conferences.
- We set out to start measuring and reporting our outcomes in real time.

Every operation can be reduced to ten steps. We have a game plan for every case. For us, perfusion strategy is step one.

Incremental improvements over time depend on accurate, real time performance measurement.
Real Time Outcomes for Congenital Heart Surgery: 2004

- We linked our electronic medical record (each patient’s legal medical record) to a web based outcomes reporting platform, and made it visible to everyone.

How to work with EMR’s:

- Designed by accountants, not doctors
- Profoundly expensive: Duke paid 700 million, and Kaiser Permanente paid 4 billion. Upgrades can be 40% of that per year.
- Brutally inefficient interfaces for clinicians
- Not interoperable
- No search capability.
- It’s cheaper to change you, than to change the EMR.

Change is possible, we modified our Cerner EMR to store our operative images and videos.

- Evaluate surgical repairs over time.
- Share novel approaches with team, family, students
- Improve surgical performance.

We have taken systematic operative images for two decades.

- Operative imaging is a compelling foundation for quality assessment and performance improvement.

http://Real time outcomes
Operative images and daily patient images are a way to validate surgical outcomes reporting.

- What we learned that voluntary, yearly outcomes reporting does not work.
- We can use routine shared imaging to increase confidence in outcomes reporting.

The iPhone Evolution began in 2007: A Smartphone as camera, documenting our lives with shared images.

YouTube was founded in 2005. In 2008, we begin to share our operative videos.

- Google Partner analytics
- 50 videos published in every country in the world for over 2 million minutes
- https://www.youtube.com/watch?v=iRtm1eH2E&t=1s

Tech evolution in operative imaging

- 2013: Google Glass
- 2015: 3D models
- 2016: VR headsets
Virtual Reality for operative planning

- The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way.
- How do you do an operation that has never been done before?

“Teegan is Inoperable”

Virtual Reality Imaging Technology for operative planning.

- Google Cardboard
- SketchFab
- i-Phone
Operative planning

Initial operative image

https://sketchfab.com/models/080cd7fa169742af959956081269b5ea

Post-Repair

Preparing for chest closure five days postop
Teegan: Postop day 26

121 + 49 + 1 + 1 = 172 days. 15 percent of her life. 1 day a week.

She might get a “Smart” Fontan

Conclusions

• Have IT staff become dedicated members of your team.
• Be active, innovative partners in the development of your perfusion information systems.
The only way to predict the future is to invent it.