Can AI help to diagnose and manage eye conditions?

Nicholas Lee, Consultant Ophthalmologist specialising in Medical Retina

Western Eye Hospital

Clementine Churchill Hospital and Bishops Wood Hospital

Tortola Vision – British Virgin Islands
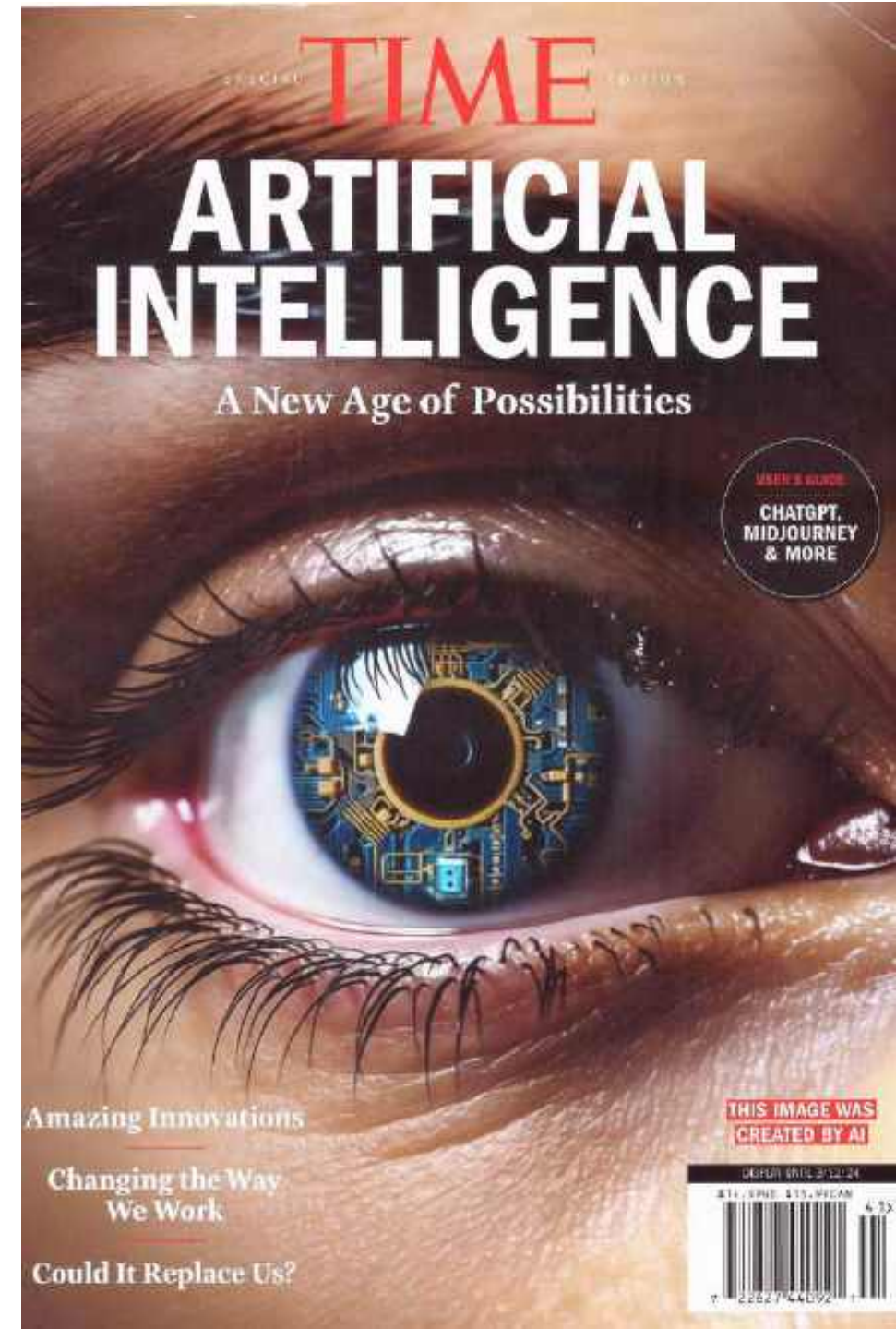
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Housekeeping

Could everyone kindly follow the below instructions for this session:

- Kindly leave any questions you have till the end of the session

- You can raise a question during Q&A's by clicking on the 'raise hand' icon or type your question in the 'chat' area and a member of the marketing team will attend to those who have asked a questions

- Please kindly keep your mic on 'muted' throughout unless it is your turn to ask a question during the Q&A

- The presentation slides will be shared if the consultant consents

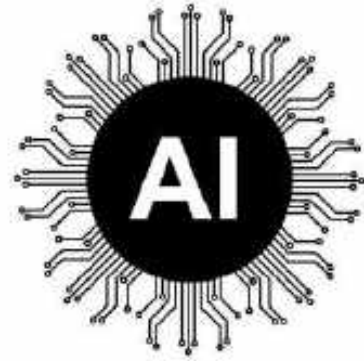- CPD certificates will be released electronically via email to the email address you have registered with.

Thank you and we hope you enjoy the session!

Bishops Wood Hospital
Part of Circle Health Group

Evolution

- To create is Human
  - - inherent drive for creativity and innovation that defines our species
- Generative AI – Creating novel content is new
  - Rapid growth by ravenous, curious public
  - ChatGPT – Responds coherently to virtually any query
  - DALL-E Conjure up any image you can dream up.
- Growth is exponential
  - January 2023 100 million monthly users milestone
  - April 2024   1,800 million Monthly users
  - Faster growth than any other software.
- Financial boost global economy – huge estimated $15 trillion.
- Make us learn faster, be more productive, communicate better
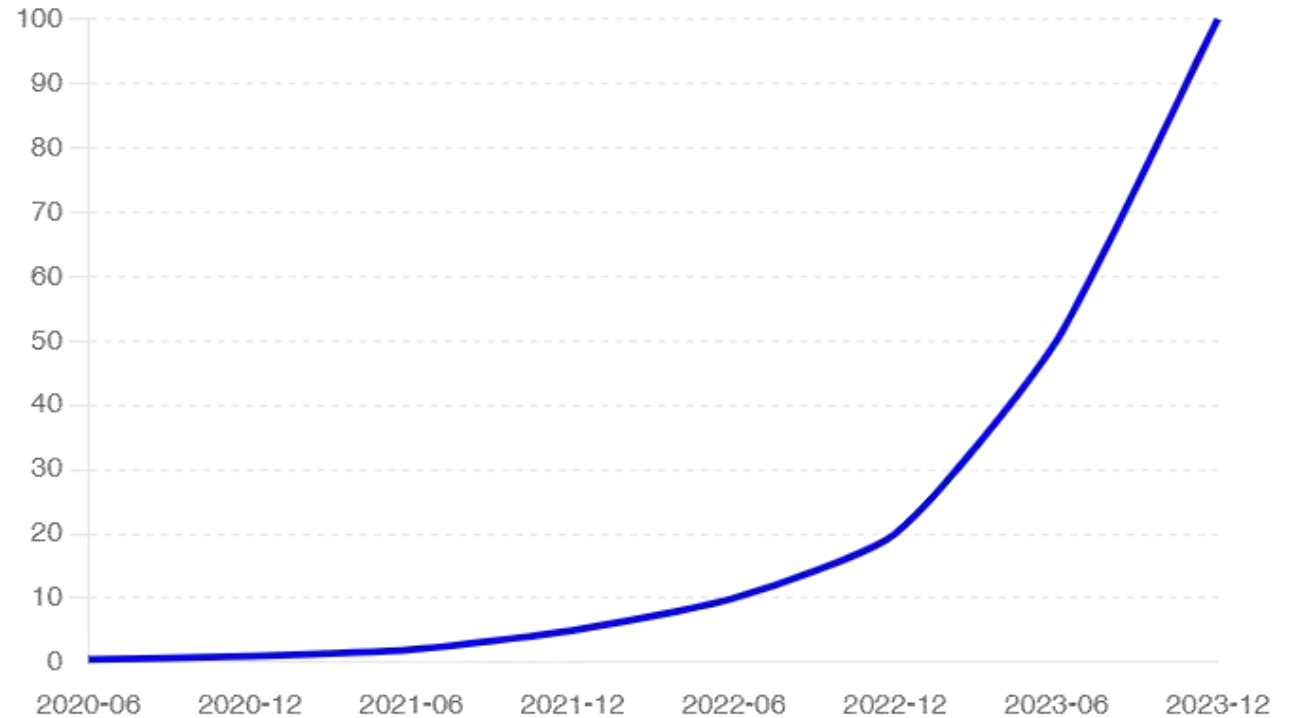- Not yet a dedicated EMH – but this will be coming to your surgery shortly!

TIME

ARTIFICIAL INTELLIGENCE
A New Age of Possibilities

USER'S GUIDE
CHATGPT, MIDJOURNEY & MORE

Amazing Innovations
Changing the Way We Work
Could It Replace Us?

THIS IMAGE WAS CREATED BY AI

ChatGPT
(Generative Pre-trained Transformer)
What is the Transformer Model?
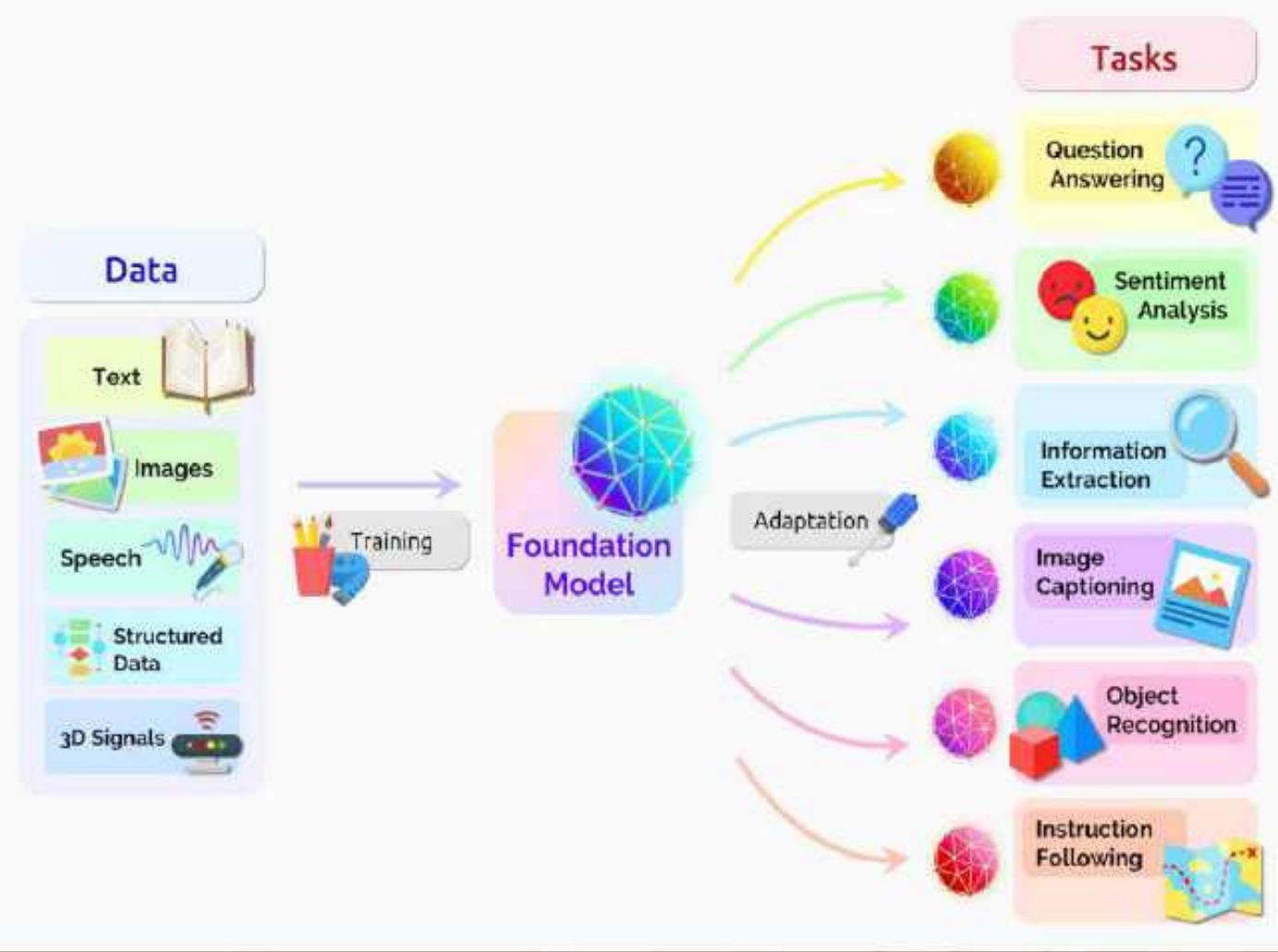
Definition – Machine Learning

- A transformer model is a neural network that learns context and thus meaning by tracking relationships in sequential data like the words in this sentence.

- First described in a 2017 paper from Google, transformers are among the newest and one of the most powerful classes of models invented to date.

- They're driving a wave of advances in machine learning some have dubbed transformer AI.

- Reinforced learning

- Huge energy consumption
    - 10 GWh to train ChatGPT
    - 1 GWh for 400 million users – or 300 Uk homes for a year.
    - Growing concern as users rise exponentially
    - Data centres in Norway/Iceland renewable energy
    - Advanced cooling/recycle energy

Neural Net

Training Model

Why do people want AI? Limitless Power!

Fastest adopted and growing software ever.

1. **Automation and Efficiency**: AI can automate repetitive and mundane tasks, improving efficiency and productivity across different industries. This automation can free up human workers to focus on more complex and creative tasks, thereby increasing overall productivity .

2. **Data Analysis and Insights:** AI systems are capable of processing and analyzing vast amounts of data quickly and accurately. This capability enables businesses and researchers to gain valuable insights, make informed decisions, and predict future trends. For example, AI in finance can identify patterns in market data that humans might miss .

3. **Personalization:** AI enables the personalization of services and products, enhancing user experience. This is evident in applications like recommendation systems used by streaming services, online retailers, and social media platforms, which tailor content and suggestions based on individual preferences and behaviors .

4. **Healthcare Improvements:** In the medical field, AI is revolutionizing diagnostics, treatment planning, and patient care. AI can assist in early disease detection, analyze medical images with high accuracy, and even predict patient outcomes, leading to more effective and personalized healthcare .
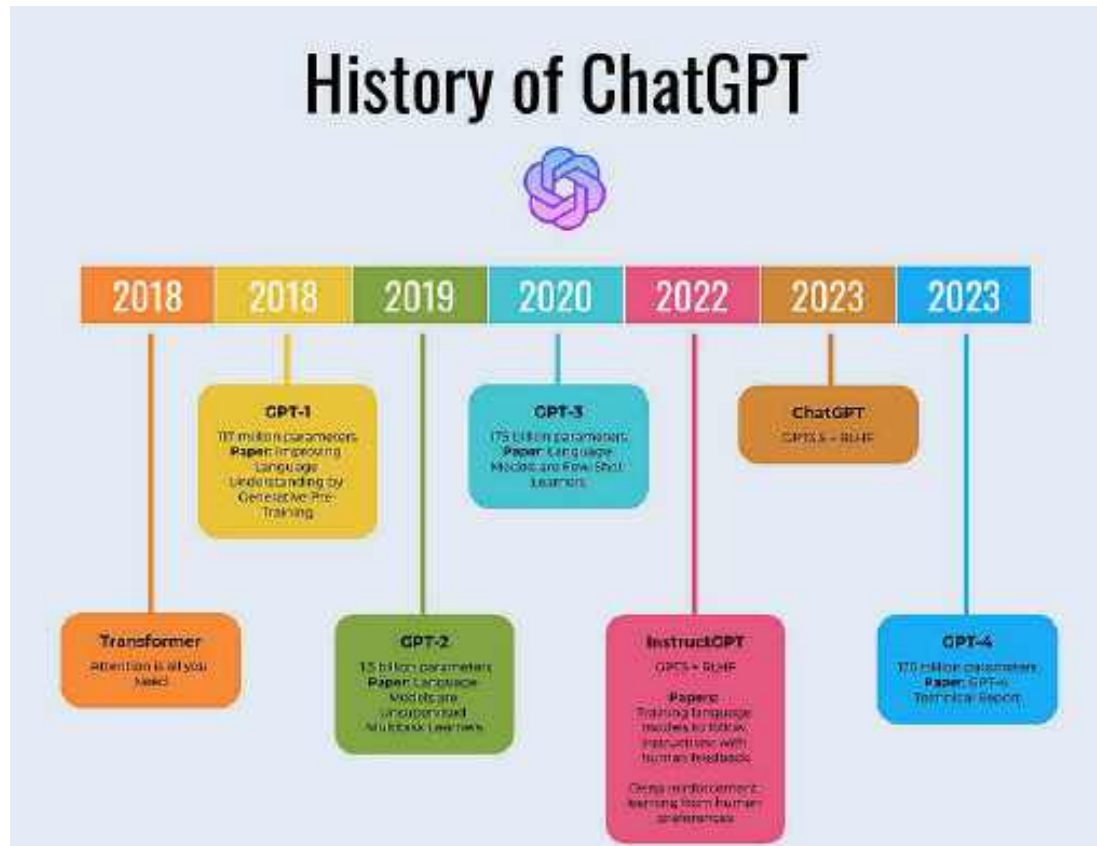
Everyone wants access –

All smart Phones can access!

5 million or 61% of world's population!

1. **Innovation and Creativity:** AI is fostering innovation by enabling new forms of creativity and problem-solving. In fields like art, music, and design, AI tools are being used to create new works, inspire artists, and solve complex creative challenges .

2. **Safety and Precision**: AI enhances safety and precision in areas such as autonomous vehicles, industrial automation, and disaster response. For example, AI-driven systems in cars can reduce human error, thereby lowering the risk of accidents .

3. **Economic Growth:** The adoption of AI technologies is seen as a driver of economic growth, providing new business opportunities and transforming existing industries. Companies investing in AI can gain a competitive edge by optimizing operations and creating innovative products and services .

4. **Accessibility and Convenience**: AI-powered tools and devices make everyday life more convenient and accessible. Voice assistants, smart home devices, and AI-based language translation services improve daily living and provide assistance to people with disabilities .

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Open AI - ChatGPT

History of ChatGPT

ChatGPT 4o - 2024 Evolutionary step

- Released May 13 2024 to ChatGPT plus/team users

- Faster, more efficient

- Enhanced multimodal capabilities eg Voice, text and vision inputs

- Improved ability to understand.

- Ability to learn from immediate user feedback
  - E.g. I asked ChatGPT 4 when was 4o released
  - It said there was not a specific 40
  - I then switched to the new 4o and asked again it got the answer 13 March 2024.
  - Back to GPT4 and it had already updated itself and gave correct date.
  - 180.5 Million users – means huge feedback

Alternative AI Models

Choice

- ChatGPT 1.8 billion / month

- Google's LaMDA (Language Model for Dialogue Applications2021) based on Transformer -142 million / month – Google assistant, work space. Is it Sentient?

- Aitestkitchen.withgoogle.com is googles platform of Video, images, music and writing soon to be conversational.

- **Microsoft's Turing-NLG**:

- **Facebook's BlenderBot**:

- Anthropic's Claude

- **Alibaba's AliceMind**:

- DeepMind's Gopher

- **IBM's Project Debater**

Different versions of ChatGPT

- **1. OpenAI Platform**

- **ChatGPT Web App**: Accessible through the OpenAI website, users can interact with ChatGPT directly via a browser-based interface.

- **API Access**: Developers can integrate ChatGPT into their own applications using OpenAI's API, which provides programmatic access to the model for customized use cases.

- **Subscription Plans**: OpenAI offers subscription plans like ChatGPT Plus, which provides enhanced access and features for a monthly fee.

- **2. Mobile Applications**

- **ChatGPT Mobile App**: OpenAI provides a mobile app for both iOS and Android devices, allowing users to access ChatGPT on the go.

Free ChatGPT vs. ChatGPT Plus

- **Free ChatGPT:**
  - **Cost**: Free.
  - **Availability:** Subject to throttling during peak times.
  - **Performance**: Slower response times during high demand.
  - **Features**: Standard model capabilities.

- **ChatGPT Plus: - Web & Mobile included**
  - **Cost:** $20 per month.
  - ChatGPT 4o access
  - **Availability:** Priority access during peak times.
  - **Performance:** Faster and more reliable response times.
  - **Features:** Access to enhanced features and potentially newer models.

- **Summary**
  - **Free Tier:** Good for casual use.
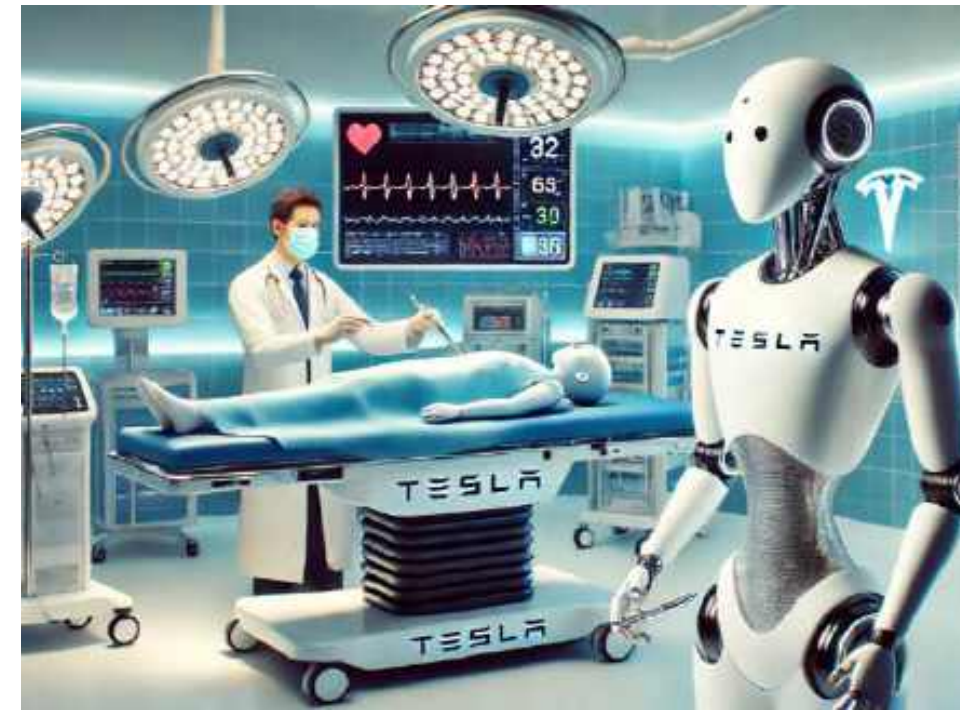 - **Plus Tier:** Better for frequent use and needing reliable performance.

OpenAI GPT-4o

- Faster response time
- Approaching human speed of response
- Built in Safety modalities
- 70+ external experts tested social psychology, bias and fairness, and misinformation to identify risks
- Text and image available now – Audio in due course etc

May 13, 2024

Hello GPT-4o

We're announcing GPT-4o, our new flagship model that can reason across audio, vision, and text in real time.

Contributions ↗   Try on ChatGPT ↗   Try in Playground ↗   Rewatch live demos ↗

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Robotic eye surgery

- **Zeiss PRECEYES surgical system CE marked**
  - 20 um precision for instruments
  - No tremors
  - Assists surgeons for delicate operations greater accuracy than manual techniques eg membrane peels in vitreoretinal sugery.
  - 2021 for sub retinal drug delivery
- **2019 Da Vinci Surgical System**
  - Robotic arms assist Pterygium, corneal transplants, strabismus, cataract surgery
- **Steady-Hand Eye Robot (SHER)**
  - Admittance-based robotic system
  - filter out hand tremors and enables ophthalmologists
- **Robot-guided Cataract Surgery**
  - Laser assisted Cataract surgery
  - 3D imaging cataract surgery
- AI Integration
  - Combing AI with robotic systems to provide real-time feedback
  - Enhance decision making during surgery
  - Decreasing reaction times.
  - Better outcomes?

Can ChatGPT been used to make diagnosis??

Patients unable to get appointments turn to ChatGPT

- Complex case example
  - Boy Alex had Chronic pain for several years
  - Seen 17 doctors unable to identify condition
  - Mother Courtney turned to ChatGPT
    - Entered MRI reports, Symptoms etc
  - AI suggested might have tethered cord syndrome
  - Confirmed – Alex underwent successful surgery

Ophthalmic Case BVI

- 17 year old female – not diagnosed, not given support at school. Attended as wished to train to be a teacher.
  - Reduced vision
  - Drooping eyelids
  - Divergent squint
  - Poor ocular movement in all directions
  - Visual fields reduced both eyes 82% & 88%
  - Salt and pepper appearance of the fundus of the eye
  - Reduced body muscle strength,
  - Reduced Balance and co-ordination
  - Hypermobility of joints especially hands and fingers
  - Normal intelligence, Normal hearing and speech.

- My thoughts – No idea !

- ChatGPT 4 – entered symptoms.

- Lets do this Live.

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Differential Diagnosis

. **Mitochondrial Myopathies**

- **Kearns-Sayre Syndrome (KSS)**
  - **Symptoms:** Progressive external ophthalmoplegia, ptosis, retinitis pigmentosa (often with salt-and-pepper appearance), muscle weakness, cardiac conduction defects, ataxia. Typical presents in teens
  - **Diagnosis:** Muscle biopsy showing ragged red fibers, genetic testing for mitochondrial DNA deletions.

- **Chronic Progressive External Ophthalmoplegia (CPEO)**
  - **Symptoms**: Ptosis, ophthalmoplegia, muscle weakness, exercise intolerance, possible retinal changes.
  - **Diagnosis**: Muscle biopsy, genetic testing for mitochondrial DNA mutations.

- **Ehlers-Danlos Syndrome (EDS)**
  - **Symptoms**: Joint hypermobility, skin hyperextensibility, and tissue fragility. Systemic symptoms can include muscle weakness and poor balance, and in some cases, retinal detachment.
  - **Diagnosis**: Clinical criteria, genetic testing for mutations in COL5A1, COL5A2, or other related genes.

Workup and Diagnostic approach

1. **Comprehensive History and Physical Examination**:
   1. Detailed family history.
   2. Progression and duration of symptoms.
   3. Specific inquiry about systemic symptoms and involvement of other organ systems.

2. **Ophthalmologic Examination**:
   1. Visual acuity testing.
   2. Fundus examination to assess retinopathy.
   3. Visual field testing.
   4. Ocular motility assessment.

3. **Neurological Examination**:
   1. Muscle strength testing.
   2. Assessment of reflexes and coordination.
   3. Evaluation of balance and gait.

4. **Laboratory Testing**:
   1. Complete blood count, metabolic panel.
   2. Creatine kinase (CK) levels.
   3. Antibody tests for myasthenia gravis.

Workup and Diagnostic approach
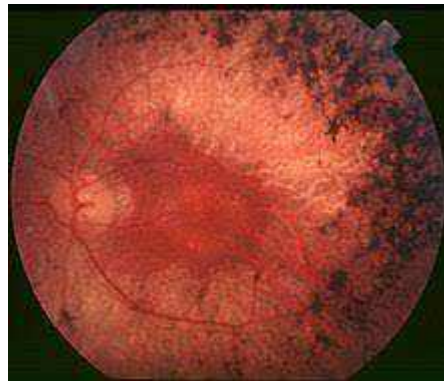
1. **Imaging**:
   1. MRI of the brain and orbits to rule out structural abnormalities.
   2. Echocardiogram and aortic imaging if connective tissue disorder is suspected.

2. **Genetic Testing**:
   1. Depending on clinical suspicion, genetic testing for mitochondrial DNA mutations, COL5A1, COL5A2, or other relevant genes.

3. **Muscle Biopsy**:
   1. If a neuromuscular disorder is strongly suspected and genetic tests are inconclusive.

Kearns-Sayre Syndrome (KSS)

- Mother been to Barbados

- Neuro-Ophthalmololgy Opinion

- MRI, blood work up done

- Mother wished second opinion

- Only informed us after I discussed the likely diagnosis.

- Michele is a paediatric physiotherapist so we could give an assessment on her muscle strengths etc

- And give physio advice.

AI -Q - She has Kearns-Sayre Syndrome (KSS).
What treatment and support for her goal of training to be a teacher is advised

Medical Management

- **Cardiac Monitoring**: Regular ECGs and echocardiograms to monitor for conduction defects and cardiomyopathy.

- **Ophthalmologic Evaluations**: Regular eye exams to monitor retinopathy and ocular motility issues.

- **Neurological Assessments**: Periodic evaluations to assess muscle strength, coordination, and any neurological progression.

- **Endocrine Assessments**: Monitoring for diabetes mellitus and other endocrine dysfunctions which can occur in KSS.

- **Coenzyme Q(10)** may decrease fatigue with improvement in eye muscle movement and a lessening in the degree of heart block. Pacemakers may be necessary in some patients. Exercise is recommended for patients with significant skeletal myopathy.

Symptomatic treatment

- **Cardiac Issues**: Pacemaker implantation if significant conduction abnormalities are present.

- **Ptosis and Ophthalmoplegia**: Surgical correction if ptosis severely impacts vision; prism glasses or eye muscle surgery for strabismus.

- **Hearing**: Regular audiological evaluations and hearing aids if needed.

- **Supportive Therapies**:
  - **Physical Therapy**: To maintain muscle strength, flexibility, and balance.
  - **Occupational Therapy**: To assist with daily living activities and adaptations for reduced muscle strength and coordination.
  - **Speech Therapy**: If speech or swallowing issues arise.

- **Individualized Education Plan (IEP)**:

- **Accommodations**: Extended time for tests, note-taking assistance, preferential seating, and breaks during classes.

- **Assistive Technology**: Use of computers/tablets with voice-to-text software, magnification devices for reading, and other adaptive technologies.
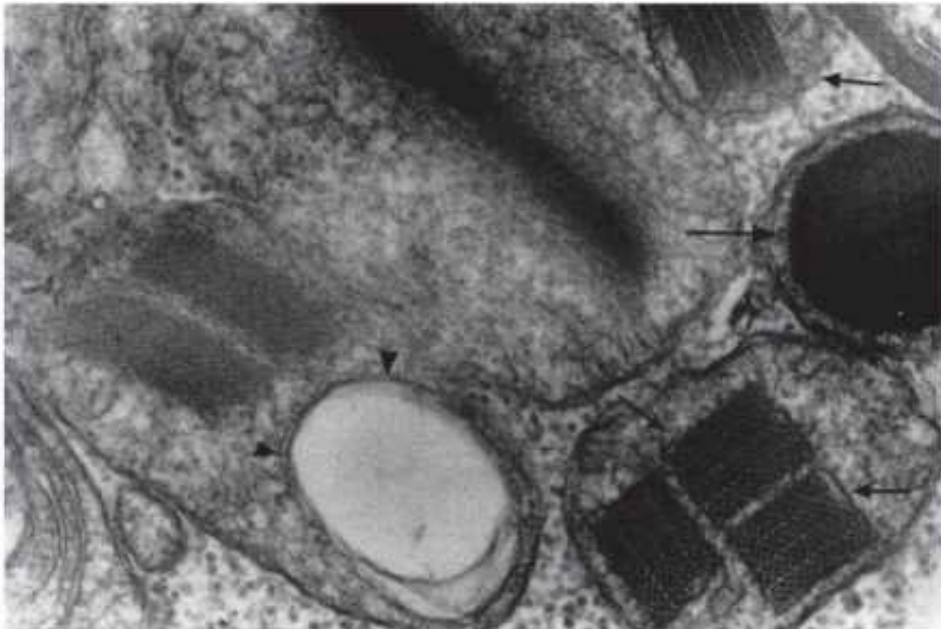
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Psychological and social support

1. **Vocational Training**:

   1. **Career Counselling**: Guidance to explore teaching specialties that may be less physically demanding.

   2. **Internships/Work Experience**: Structured internships with supportive mentors to provide practical teaching experience.

2. **University and College Support Services**:

   1. **Disability Services Office**: Liaison with university disability services to ensure appropriate accommodations and support.

   2. **Tutoring and Academic Support**: Access to tutoring services to assist with coursework.

1. **Counselling**:

   1. **Psychological Support**: Regular counselling sessions to address any emotional or psychological issues related to chronic illness and disability.

   2. **Support Groups**: Participation in support groups for individuals with mitochondrial diseases to share experiences and coping strategies.

2. **Peer and Mentor Support**:

   1. **Mentorship Programs**: Connecting with teachers who have disabilities for mentorship and support.

   2. **Peer Support**: Encouraging a supportive peer network within the educational institution.

3. Lifestyle Modifications

   1. **Energy Conservation**:

   2. **Activity Management**: Balancing rest with activity to prevent fatigue.

   3. **Nutrition**: Balanced diet with adequate hydration to support overall health.

   4. **Safety Modifications**:

      1. **Home and Classroom Safety**: Adaptations to ensure safe mobility and prevent falls.

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Why Consider AI Assistance in General Practice for Eye Patients?

2-5% of GP consultations eye related ie Low

- Given the specialized nature of eye conditions and the lower frequency of eye-related consultations, GPs often face challenges in accurately diagnosing and managing these cases

- 1-2 weeks of Ophthalmology at Medical School

- Limited Post graduate training.
    - Less face to face Lunchtime GP meetings
    - ? Has that changed with On-line talks

- Limited eye equipment in GP surgeries – on line consults?
    - Vision Charts, including colour vision
    - Slit lamps, Visual Fields, Tonometer's.

- Easy access to Optometrists

- Eye Casualties

- Hospital Referrals

- Private Care

AI is here to Help - Enhanced Diagnostic Support:

- **Symptom Analysis**: "**Its all in the History**"
    - 76% accuracy on History alone 90% with examination.
    - AI can help GPs analyse symptoms more thoroughly and suggest potential conditions.
    - E.g. if a patient presents with symptoms like red eyes, pain, and blurred vision, AI can list conditions such as conjunctivitis, uveitis, or glaucoma.

- **Differential Diagnosis**:
    - AI can assist in generating differential diagnoses, considering multiple possible conditions based on the symptoms provided.

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