

18th International Conference of the
Research Institute of Ophthalmology

RIO 2026

22 -23 JANUARY 2026
ROYAL MAXIM PALACE KEMPINSKI, CAIRO

Evolution of refractive surgery
techniques: From corneal biomechanics
to AI-driven personalization

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Disclosure

- None

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20 years
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Minas Aslanidis



Port Said circa 1970



Heraklion circa 1970

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GLOBAL TREND

Cataract Surgeries (Millions per Year)			
Region	1990s(~1990)	2025 (Recent)	2035 (Projection)
USA	~2,0 M	~3,8-4,0M	~6,0M
Wider Europe	~3,0-3,5 M	~5,5-5,8M	-6,50-7,5M
India	~1,2 M	~8-10M	~11-14M
China	~0,14 M	~4,2-4,9M	~5,0-6,0M

Estimation of total number of cataract surgeries worldwide: ~28M/year (~75K/day)

GLOBAL TREND

CAGR - Cataract Surgery Volume

Region	2000-2025	2025-2035
USA	+1,80 %	+4,60 %
Wider Europe	+1,30 %	+2,60 %
India	+3,90 %	+3,20 %
China	+9,20 %	+2,80 %
Global (approx.)	+3,60 %	+3,00%

- China (2000-2025): explosive infrastructure build-up phase
- USA (2025-2035): acceleration driven by aging (baby boomers →80+)
- India: structurally high growth but stabilizing
- Europe: mature, slower growth

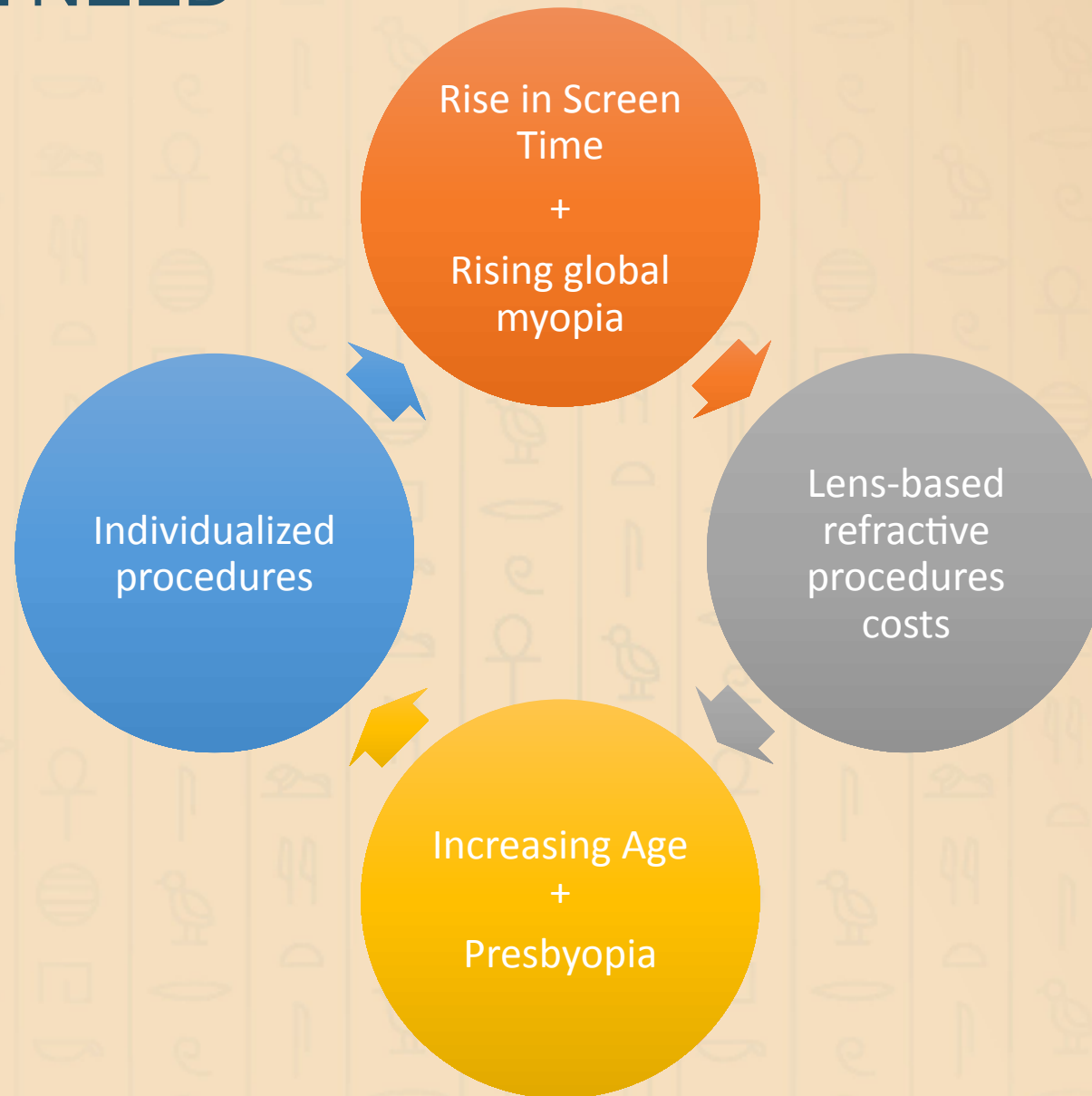
CAGR - Total Refractive Surgery (Laser+ICL)

Region	2000-2025	2025-2035
USA	-0,60 %	+3,20 %
Wider Europe	-0,30 %	+3,10 %
India	+7,60 %	+4,70 %
China	+11,00 %	+4,30 %
Global (approx.)	+4,50 %	+3,80 %

- USA & Europe:
- 2000-2025:saturation, price erosion, demographic shift
- 2025-2035: recovery via SMILE + presbyopia solutions + ICL
- China: fastest refractive growth market in history of ophthalmology
- India: strong middle class

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INTERNATIONAL NEED



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Market Scope/OBN: <https://ophthalmologybreakingnews.com/market-scope--refractive-market-growth-will-reach-%2412-billion-driven-by-lens-based-procedures>

Pharmiweb: <https://www.pharmiweb.com/press-release/2025-01-31/refractive-surgery-device-market-poised-for-steady-growth-expected-to-reach-usd-3123-million-by-20>

NEW TRENDS - TODAY

ICL

✓ Advantages

- Collamer-based, biocompatible
- **Reversible** procedure
- Dry eye-sparing
- Ideal for high myopes
- Perfect for thin corneas
- Suitable for younger patients

✓ Expanding Indications

- Hyperopia models
- Toric correction
- Presbyopia correction (emerging)
- High patient satisfaction
- Growing clinical evidence



LAL

Light adjustable lens offering refractive correction after cataract surgery → 3 - 5 light treatments ~ 90 seconds each

Macromers in the IOL undergo **photopolymerization** using an office-based Light Delivery Device (LDD) adjusting vision to the desired target



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NEW TRENDS - TOMORROW

Ophthalmic capsules

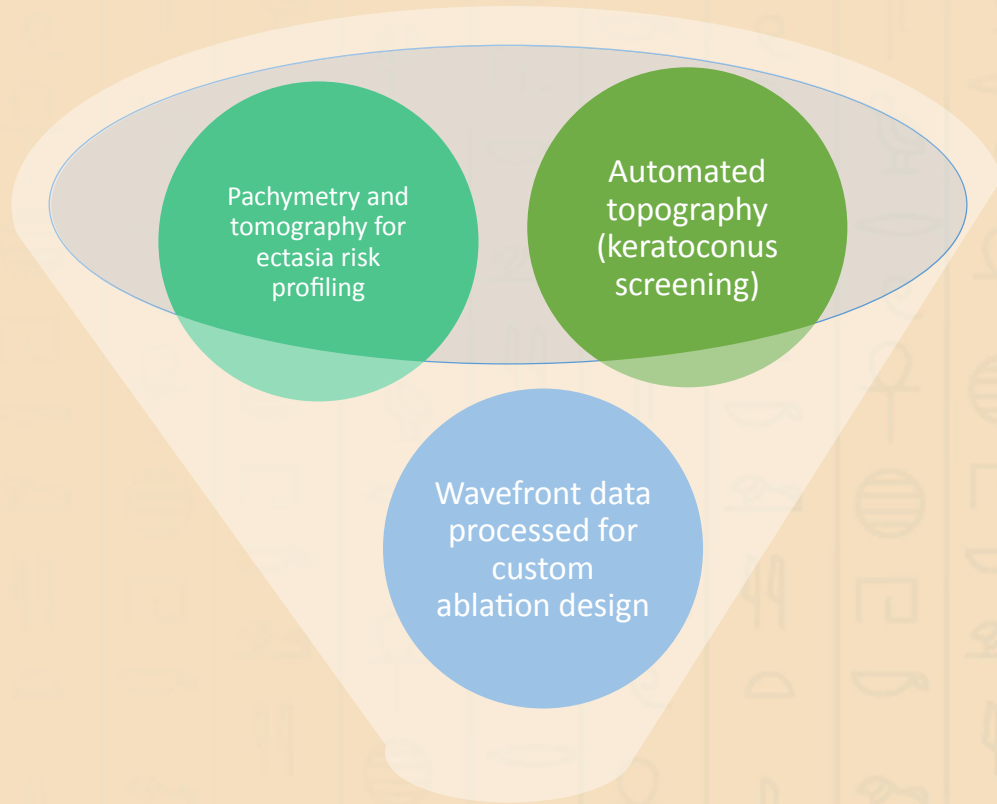
- Ophthalmic capsules (Gemini, by Omega Ophthalmics in video) **that could replace the natural lens**
- The container could act as vehicle with which **drugs** could be **delivered**, and manufacturers can **fit** different **sensors** and **AR/VR** tech. An augmented map would help patients get around easier, while health-related notifications popping up in front of their eyes would keep them “in the know” → military applications

Fluid Optic IOL

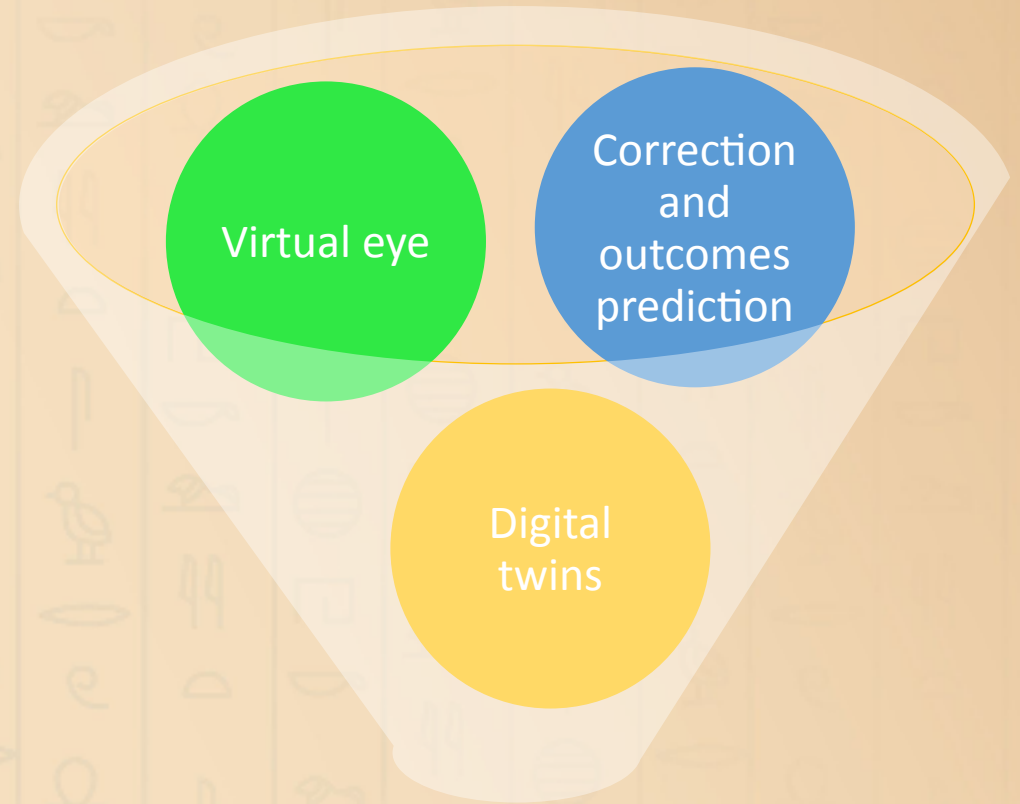
- Juvene IOL (LensGen), modular, shape-changing fluid optic IOL
- Consists of a capsule-filling base lens and a fluid lens that fits into the base lens and has a shape-changing anterior surface
- Accommodating IOL → changes in curvature with contraction of the ciliary body, similar to the natural crystalline lens
- Amplitude of accommodation about 3 diopters providing excellent range of vision without causing unwanted dysphotopsias or decreased contrast sensitivity

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ROLE OF ARTIFICIAL INTELLIGENCE



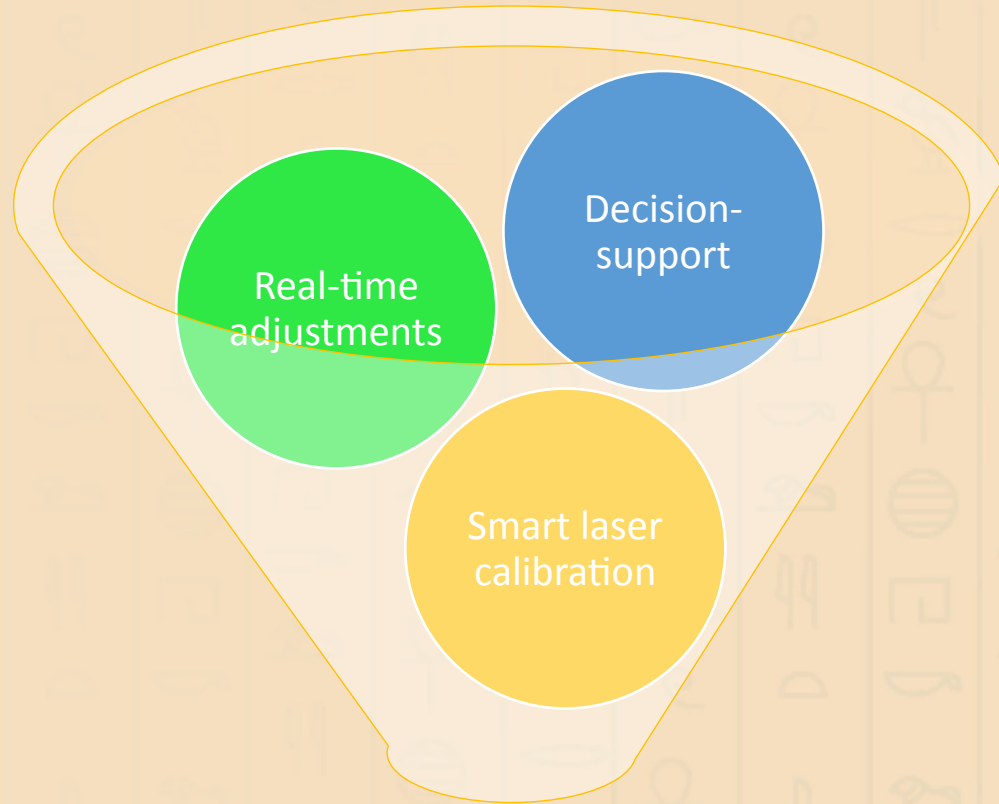
AI Diagnostic



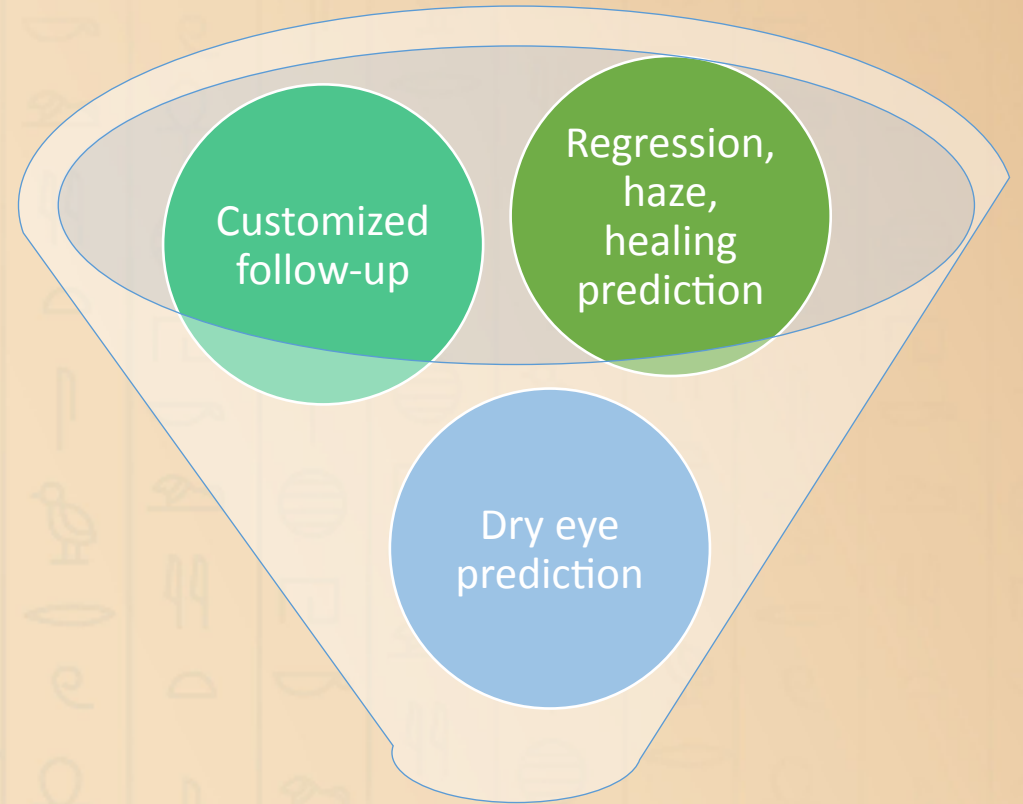
AI Surgical

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ROLE OF ARTIFICIAL INTELLIGENCE



AI Intraoperatively

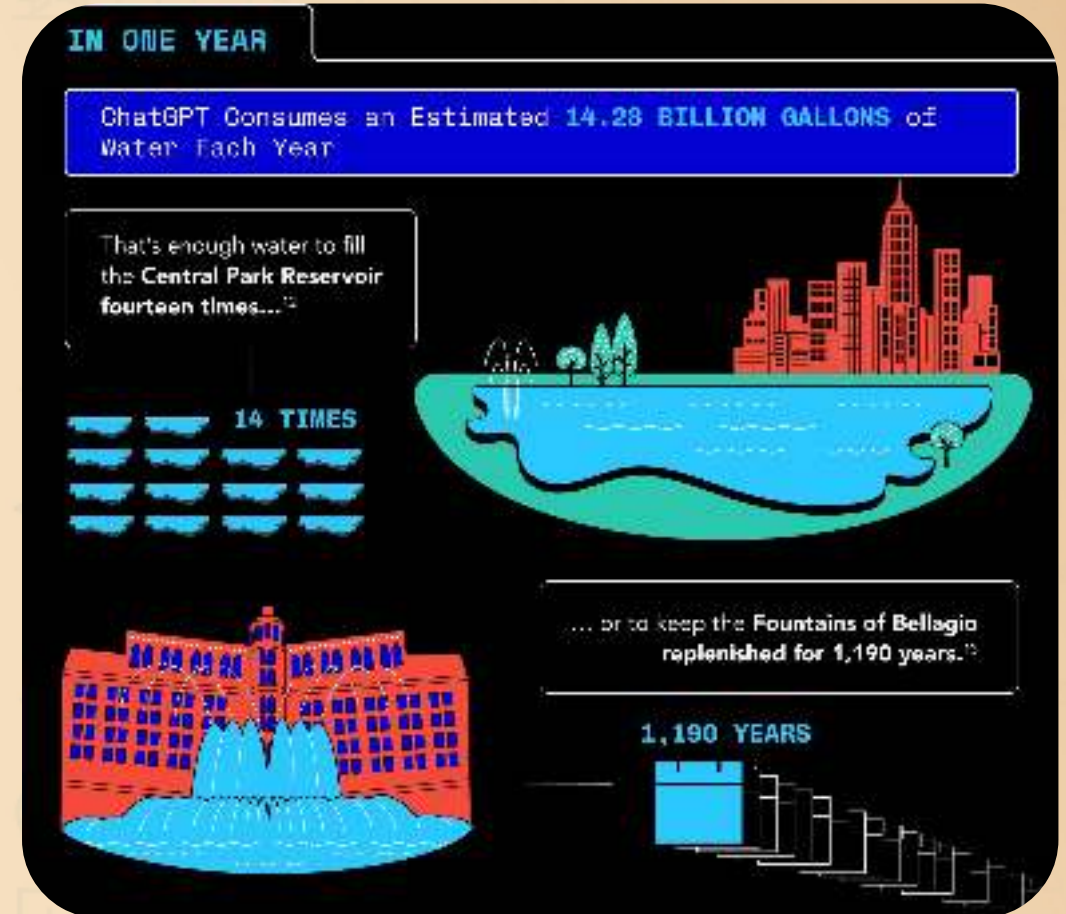
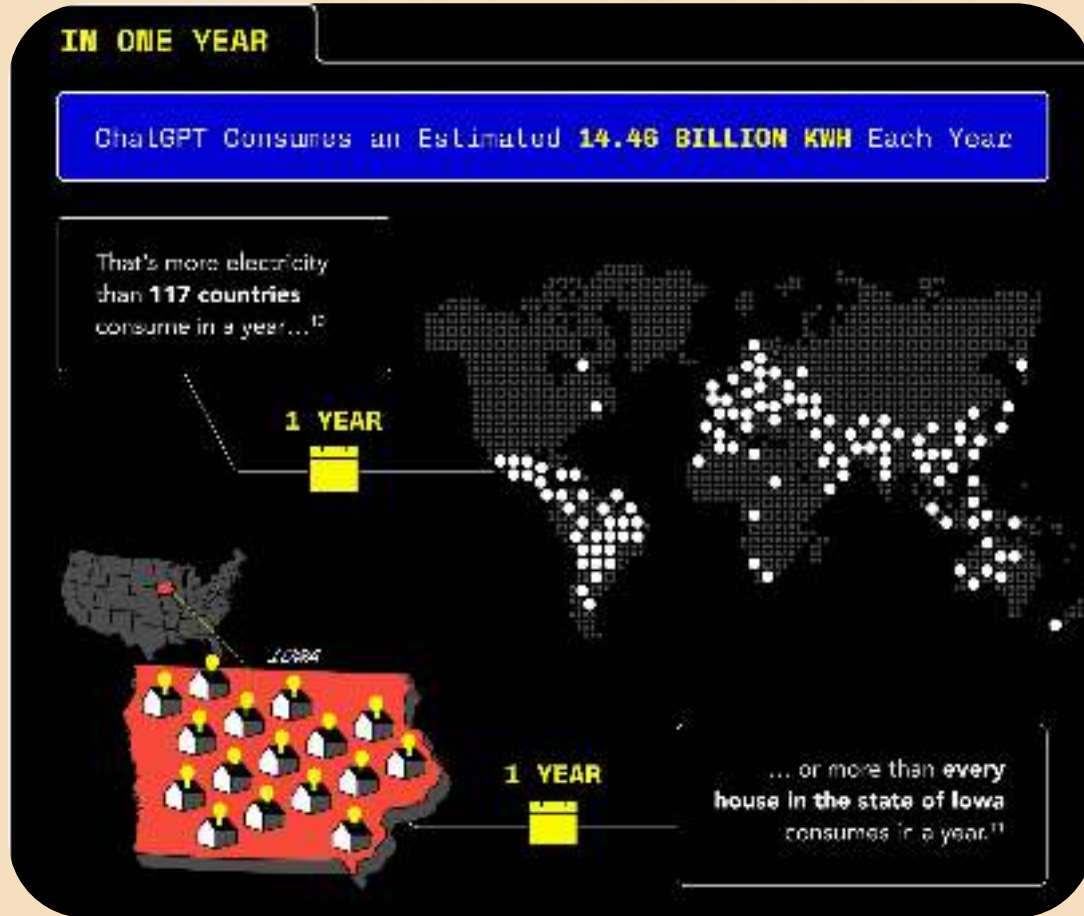


AI Postoperatively

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THE ENERGY HUNGER OF AI

What Powers the Intelligence Behind the Screen



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<https://www.businessenergyuk.com/knowledge-hub/chatgpt-energy-consumption-visualized/>

AI CHALLENGES & CONSIDERATIONS

What We Must Address

Automation Bias & Over-Reliance

The tendency to favor AI-generated decisions even when human judgment suggests otherwise

- Loss of clinical judgment skills ("use it or lose it")
- Defensive medicine around AI
- Erosion of surgical autonomy

"Moral Gap"

Who owns the decision: surgeon or AI? This question must be answered before widespread adoption.

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LEGAL & ETHICAL FRAMEWORK NEEDED



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▼ Notable fatal crashes

Handan, Hebei, China (January 20, 2016)

Williston, Florida, US (May 7, 2016)

Mountain View, California, US (March 23, 2018)

Kanagawa, Japan (April 29, 2018)

Delray Beach, Florida, US (March 1, 2019)

Key Largo, Florida, US (April 25, 2019)

Fremont, California, US (August 24, 2019)

Cloverdale, Indiana, US (December 29, 2019)

Gardena, California, US (December 29, 2019)

Arendal, Norway (May 29, 2020)

Montreal, Quebec, Canada (May 29, 2020)

List of Tesla Autopilot crashes

1 language

Article

Talk

Read

Edit

View history

Tools

From Wikipedia, the free encyclopedia

Tesla Autopilot, a Level 2 advanced driver assistance system (ADAS), was released in October 2015 and the first fatal crashes involving the system occurred less than one year later. The fatal crashes attracted attention from news publications and United States government agencies, including the National Transportation Safety Board (NTSB) and National Highway Traffic Safety Administration (NHTSA), which has argued the Tesla Autopilot death rate is higher than the reported estimates.^[1] In addition to fatal crashes, there have been many nonfatal ones. Causes behind the incidents include the ADAS failure to recognize



The Model S after it was involved in a crash.

As of October 2025, there have been hundreds of nonfatal incidents involving versions of Autopilot^[2] and sixty-five reported fatalities, fifty-four of which NHTSA investigations or expert testimony later verified and two that NHTSA's Office of Defect Investigations determined as happening during the engagement of Full Self-Driving (FSD) after 2022.^[3] Collectively, these cases culminated in a general recall in December 2023 of all vehicles equipped with Autopilot, which Tesla claims it resolved by an over-the-air software update. Immediately after closing its investigation in April 2024, NHTSA opened a recall query to determine the effectiveness of the recall.^[4]

Personal

[show]

Companies

[show]

Appearance

hide

Text

☐ Small

☒ Standard

☐ Large

Width

☒ Standard

☐ Wide

Color (beta)

☐ Automatic

☒ Light

☐ Dark

The back-up driver of a Volvo self-driving car that killed a pedestrian has been charged with negligent homicide.

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AI/ROBOTICS IN OPHTHALMOLOGY TODAY

Already in Operating Rooms and under Research



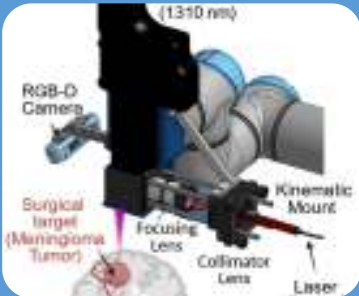
PRECEYES (VR Surgery)

- Human hand tremor: 50-100 microns
- Robotic precision: <10 microns
- ✓ FDA-approved
- ✓ Currently in use



Polaris System (Cataract)

- Dr. Uday Devgan: World's first robotic-assisted cataract surgery
- Real-time guidance
- Precision enhancement



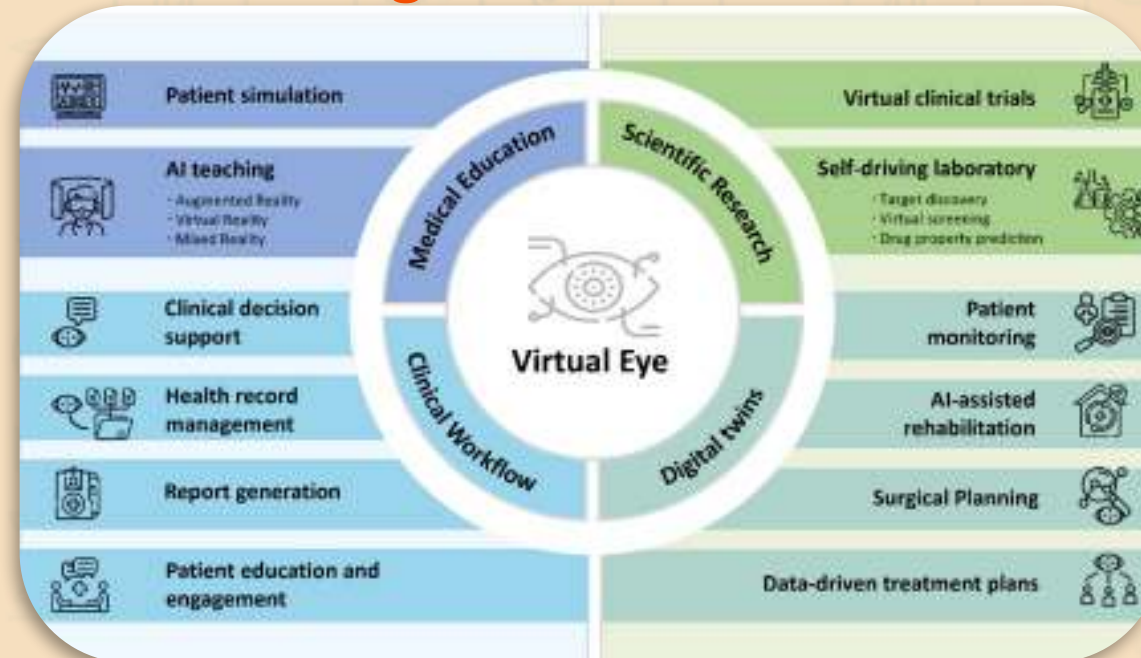
RATS Platform (Research)

- OCT-guided robotic laser surgery
- Closed-loop volumetric resection
- Sub-millimeter accuracy (0.161 ± 0.031 mm)
- Neurosurgery applications

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WHAT'S ON THE HORIZON?

- The digital “twin eye” concept
- **Biometric + imaging** data to simulate patient-specific eye
- Try **different treatment plans virtually** before committing
- May be **combined with AI co-surgeons** in future ORs



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FUTURE NEW TRENDS

➤ 3-D printed corneas

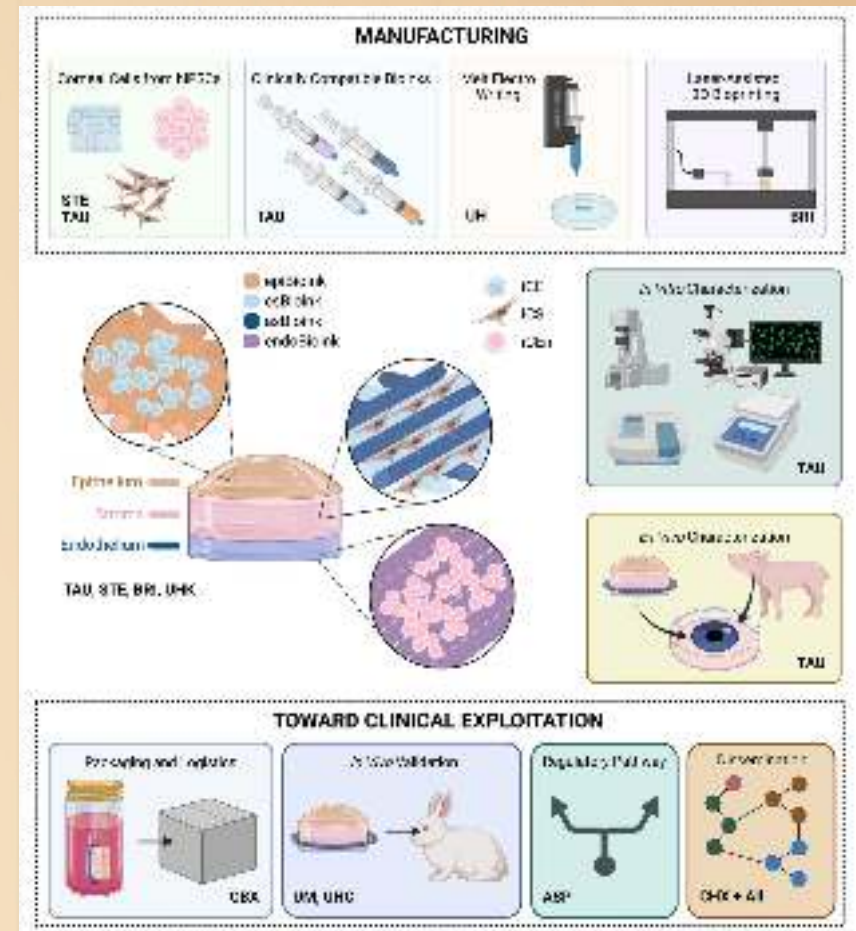
- Proof-of-concept research, which includes **mixing stem cells from a healthy human donor with alginate and collagen** to create a “bio-ink” that can be extruded through a 3-D printer in the shape of a human cornea. The stem cells then cultivate in the printed cornea
- Questions to be answered:
 - Will it structurally be able to allow a suture to safely pass through it?
 - Will it allow fluids and nutrients to pass through it while allowing the cells within it to maintain IOP?
 - Will it maintain optical clarity and not distort image quality?
 - Will it allow normal or functional IOP measurements?
 - Will it stand the test of time in a human without degrading, melting or extruding from the surrounding tissue?



WHAT'S ON THE HORIZON?

➤ 4-D printed corneas

- Keratoprinter project
- Funded under the Horizon Europe Framework Programme with 8M euros
- The project proposes a highly ambitious approach to develop a 4D bioprinting suite that can deliver a fully functional, biocompatible, full-thickness native-like human cornea:
 - Innovative & scalable cell source** with high cell **viability** & **native-like functionality** in vivo for the different cell types in the cornea
 - Several **multi-material bioink formulations** which can reproduce the native-environment heterogeneity & extracellular matrix to **deliver the optical, mechanical & biological functionality**
 - Single-cell bioprinting resolution with μm accuracy & in-process monitoring for **clinical-level quality** control at **viable printing speeds**
 - Clinical handling technology for **transportation, logistics & surgical implementation**, supported by complementary implementation of multiple bioprinting technologies
 - GMP-compliant cell manufacturing** and bioprinting technologies supported by in vivo & **GLP studies** for fast translation to the clinical environment
 - Early regulatory engagement augmented by a **thorough regulatory and ethical analysis** culminating in a comprehensive regulatory pathway to **support future commercialisation**
 - A **dedicated community of researchers, clinicians, healthcare providers, regulatory and standardisation bodies, patient groups, technology developers, & industry** to translate project results into targeted outcomes & long-term impacts



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<https://www.keratoprinter-project.eu>
<https://cordis.europa.eu/project/id/101191726>

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EYE VALLEY @ CHINA – THE NEW EPICENTER



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Thank you for your attention



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