Personalized medicine: Toward innovative solutions to meet healthcare challenges

Speaker: Jérôme Mouly
The global transformation of healthcare

Healthcare sector is currently transforming thanks to the convergence of several key parameters: economic, societal and technological.
PREVALENCE & COST OF CHRONIC DISEASES

- **Diabetes**: 422M, $827B
- **Epilepsy**: 50M, $15.5B
- **Infertility**: 48.5M
- **Sleep Apnea**: 100M, Undiagnosed cost $150B (US)
- **Parkinson**: 10M, $25B* (USA Only)
- **Cardiovascular events**: 1.5B, $950B
- **Sleep Apnea**: 100M
- **Diabetes**: 422M
- **Epilepsy**: 50M
- **Infertility**: 48.5M
- **Sleep Apnea**: 100M
- **Diabetes**: 422M
- **Epilepsy**: 50M
- **Infertility**: 48.5M

*Source: Reports from World Health Organization

©2019 | www.yole.fr | Semicon Europe – Smart Medtech Forum
CONVERGENCE OF DIGITAL TECHNOLOGIES

Drivers and impacts

Acceleration of digital technology

Results

Prevention

Prediction

Management

Diagnosis

Disease


Wireless sensors & devices
Mobile connectivity
Social networking
Genomics
Internet
Data Universe

©2019 | www.yole.fr | Semicon Europe – Smart Medtech Forum
A NEED TO CHANGE

Evidence-based medicine

4P Medicine

Predictive

Personalized

Preventive

Participative
Personalized medicine is a move away from a "one-size fits all" approach to the treatment and care of patients.
A NEW PATIENT CENTRIC APPROACH

Micro-technologies are expected to provide strong value for consumer healthcare.
The success of this new market depends on how the industry manages the challenges.
WHAT DOES PERSONALIZED MEDICINE INVOLVE?

- Disruptive diagnostic solutions
- Innovative drugs
- Smart delivery

Picture: Oxford Nanopore (GridION chips)
DISRUPTIVE DIAGNOSTIC SOLUTIONS

- Connected medical devices
- Wearables
- NGS and DNA sequencing
- Liquid Biopsy
AN INCREASING NUMBER OF CONNECTED MEDICAL DEVICES AND WEARABLES

* Non exhaustive list of products
BRIDGING THE GAP BETWEEN MEDICAL SECTOR AND MICROELECTRONICS

Monitoring and tracking of behavioral health, brain & nerve activity and stress
EEG
- Monitoring of chronic conditions such as diabetes
CGM
- Continuous monitoring of vital signs such as cardiac arrhythmias and heart rate enables whole health profiling, versus today’s standard of sporadic sampling
Heart rate/ECG/optical sensors/ PPG
- Capture of local muscle activation for rehabilitation, motion study and tone assessment
EMG
- Superior thermal and fluidic transport
Temperature & galvanic skin response
- Superior mechanical coupling to the body, reduces motion artifacts that cause noise
Activity tracker
- UV sensing on the body to prevent sun damage
UV
- Correction and improvement of hearing function
Hearing aids
- Superior mechanical coupling to the body, reduces motion artifacts that cause noise
Activity tracker
- Superior thermal and fluidic transport
Temperature & galvanic skin response
- Microphones
Hearing aids
- Thermophile sensors
Temperature & galvanic skin response
- Microphones
Hearing aids
- Electrodes
EEG
- Micropumps
CGM
- Pressure sensor
Heart rate/ECG/optical sensors/ PPG
- Glucose sensors
CGM
- Electrodes
EEG
- Electrodes
EEG
- Pressure sensor
Heart rate/ECG/optical sensors/ PPG
- Activity tracker
- Biochips
- Accelerometer
- Gyroscope
- UV sensors
- Thermophile sensors
- Microphones
- Electrodes
- Electrodes
- Glucose sensors
INTEGRATE MORE AND MORE SENSORS…

Contribute to generate data from a patient:
- to diagnose first signs of a disease
- to understand patient's environment
MEDICAL WEARABLE GLOBAL MARKET FORECAST 2018-2024

- A global growth of 28.5%
- Higher revenues in chronic diseases:
  - Diabete
  - Respiratory
  - Neuro-degenerative diseases
  - Cardiovascular

CAGR 2018-2024: 28.5%
NEXT GENERATION AND DNA SEQUENCING

Powerful tools for personalized medicine

Human genome project
~$2.7B, 13 years

Introduction of NGS

©Yole Développement – April 2019

~200k human genomes have been sequenced so far

~1.5M human genomes have been sequenced so far

Early next-generation sequencers
~$1M/genome, weeks

Illumina HiSeq 2000
~$10k/genome
~10 days

Illumina HiSeq X Ten
~$1K/genome
~3 days

BGI MGISEQ-2000
~$600/genome
~3 days

ONT PromethION
~$800/genome
~3 days

Where will we be in three years? In five years?
**Key requirements for next generation flow cells:**

- Increase throughput / number of wells
- Decrease the price of the device → cheaper sequencing procedures
AND WHAT’S NEXT?

We’re only at the very early days of sequencing…

Sequencer installed base: ~30k in 2018

Sequencing flow cells per year: ~1.3 million in 2018
AND WHAT’S NEXT?

We’re only at the very early days of sequencing…

Sequencing flow cells per year

Sequencer installed base

Inflexion point… But when?
AND WHAT’S NEXT?

We’re only at the very early days of sequencing…

Sequencer installed base

Sequencing flow cells per year

Inflexion point… But when?

$100 genome, $10 genome, break the barrier that will enable mass adoption of sequencing
MARKET DATA AND FORECASTS, MARKET SHARE

Number of sequencing flow cells, per material

2018
1.28M flow cells

- 0.92M units (72%)
- 0.36M units (28%)

2024
4.19M flow cells

- 2.17M units (52%)
- 2.01M units (48%)

CAGR +21%

©2019 www.yole.fr Semicon Europe – Smart Medtech Forum
WHAT DOES PERSONALIZED MEDICINE INVOLVE?

• Disruptive diagnostic solutions

• Innovative drugs

• Smart delivery

Picture: Mimetas – OrganoPlate 3-lane (details)
A combination of microtechnology…

… and biology

Lung-on-a-chip model developed at the Wyss Institute

Organs-on-chips represent the convergence of several areas of research:

- Microfluidics
- Microfabrication
- Tissue engineering
- Stem-cell biology (providing easy access to non-malignant human cell lines and patient-specific stem cells, enabling creation of general human models and patient-specific models)
At the outset, OOC devices were expected to be used in late-stage preclinical trials, replacing tests on animals. However, it appears that an increasing number of OOC devices are used during the early stages of drug discovery - screening a high number of compounds to avoid excluding potential good compounds early in the process.
WHAT ORGAN ON CHIPS ALLOW FOR PERSONALIZED MEDICINE

• Current interest in Organ on Chips is to reduce clinical trial time and save money
  • Toxicity, side effects
  • Efficacy testing
  • Disease mechanism models

• Next challenges:
  • Patient's cells on chip to develop personalized medicine for cancer and chronic diseases
  • Body on chip – connecting several organs for a global understanding

©2019 | www.yole.fr | Semicon Europe – Smart Medtech Forum
Individually tailored organs-on-chips with a patient's own cells, allowing biology to be predicted on a person-by-person basis.

Personalized organs-on-chips containing a person's own living cells.
WHAT DOES PERSONALIZED MEDICINE INVOLVE?

• Disruptive diagnostic solutions

• Innovative drugs

• Smart drug delivery

Picture: Purdue University – Biopatch for precision drug delivery
SMART DRUG DELIVERY – EXAMPLE OF DIABETE

More than 1 in 10 Americans will have diabetes in 2025

Source: Diabeloop
HYBRID CLOSED-LOOP SYSTEM TO PERFORM SMART DRUG DELIVERY

- MiniMed 670G from Medtronic → First hybrid closed-loop system approved by the FDA

- Commercially available

- Adjusted drug delivery from the sensor, on the basis of user information

- What about AI?

- Final goal → Closed-loop system "artificial pancreas"
PERSONALIZED MEDICINE CHALLENGES…

...meeting microtechnologies solutions

• Personalized medicine impact the medical sector at different level

• The major challenge is to adapt medication and way to deliver it to EACH patient, in a cost effective way

• Micro-technologies latest development allow precise, accurate, reliable generation of data

• Requirement of the healthcare organizations to reduce cost of disease should democratize the use of this kind of solutions

• Serial manufacturing processes will be a key factor to decrease cost of these solutions
YOLE DEVELOPPEMENT – FIELDS OF EXPERTISE WITHIN 3 MAIN DOMAINS

**Semiconductor & Software**
- Semiconductor Packaging and Substrates
- Semiconductor Manufacturing
- Memory
- Computing and Software

**Photonics & Sensing**
- Photonics
- Lighting
- Imaging
- Sensing & Actuating
- Display

**Power & Wireless**
- RF Devices & Technologies
- Compound Semiconductors & Emerging Materials
- Power Electronics
- Batteries & Energy Management
FIELD OF EXPERTISE IN LIFE SCIENCE & HEALTHCARE

Our DNA: combination of two different worlds

MICROELECTRONICS
More than Moore Devices
& derived products

LIFE SCIENCES & HEALTHCARE
BIOLOGY, CHEMISTRY
SEVERAL COMPANIES TO SERVE YOUR BUSINESS

Yole Group of Companies (non exhaustive)

Market, technology and strategy consulting
www.yole.fr

Manufacturing costs analysis
Teardown and reverse engineering
Cost simulation tools
www.systemplus.fr

IP analysis
Patent assessment
www.knowmade.fr

Market, technology and strategy analysis
Reverse engineering & reverse costing
Patent analysis
4 TYPES OF SERVICES

- **Consulting and Analysis**
  - Market data & research, marketing analysis
  - Technology analysis
  - Strategy consulting
  - Reverse engineering & costing
  - Patent analysis
  - Design and characterization of innovative optical systems
  - Financial services (due diligence, M&A with our partner)

- **Syndicated reports**
  - Market & technology reports
  - Patent investigation and patent infringement risk analysis
  - Teardowns & reverse costing analysis
  - Cost simulation tool [www.i-Micronews.com/reports](http://www.i-Micronews.com/reports)

- **Monitors**
  - Monthly and/or Quarterly update
  - Excel database covering supply, demand, and technology
  - Price, market, demand and production forecasts
  - Supplier market shares

- **Media**
  - i-Micronews.com website
  - @Micronews e-newsletter
  - Communication & webcast services
  - Events: TechDays, forums,…

©2019 | www.yole.fr | Semicron Europe – Smart Medtech Forum
THANK YOU FOR YOUR ATTENTION!

Some slides from this presentation have been taken from the following reports:

Medical Wearable market and technology report
Released in March 2019 – More info on www.i-micronews.com
200+ slides report

Organ-on-Chips market and technology report
Released in October 2019 – More info on www.i-micronews.com
220+ slides report

Next Generation Sequencing and DNA synthesis report
Released in April 2019 – More info on www.i-micronews.com
230+ slides report

Contact: Jerome Mouly – email: jerome.mouly@yole.fr