Body Sensor Networks: The Ultimate Diagnostic Tool?

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Mapping trends by certainty and impact

High Impact Low Uncertainty

Trends with a high potential impact, which are more certain are:
- Rising patient expectations
- E health and use if IT
- **Widespread use of intelligent devices and expert systems**
- **Miniaturisation of diagnostic tools**
- **Aging population and increase in chronic disease**
- **Common use of remote consultations and home monitoring for patients**
- Ageing labour force and reducing participation rates
- The widespread use of genetic screening and mainstream use of pharmacogenetics

"Wild Cards" High Impact High Uncertainty

Trends with a high potential impact, which are more uncertain are:
- Major pharmaceutical innovation reaching the market
- Expert Patients generating a significant increase in self-care
- Emergence of new "exotic" disease

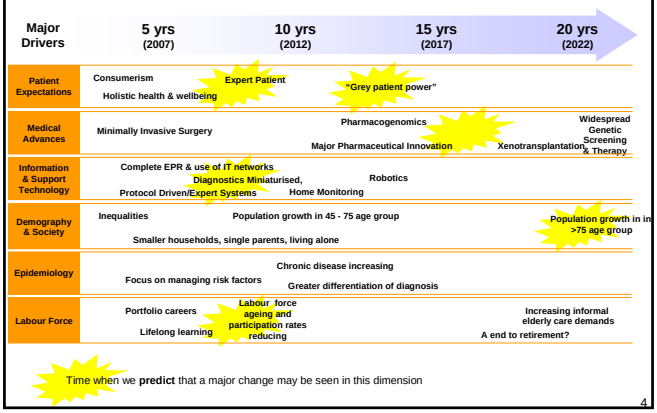
Low Impact Low Uncertainty

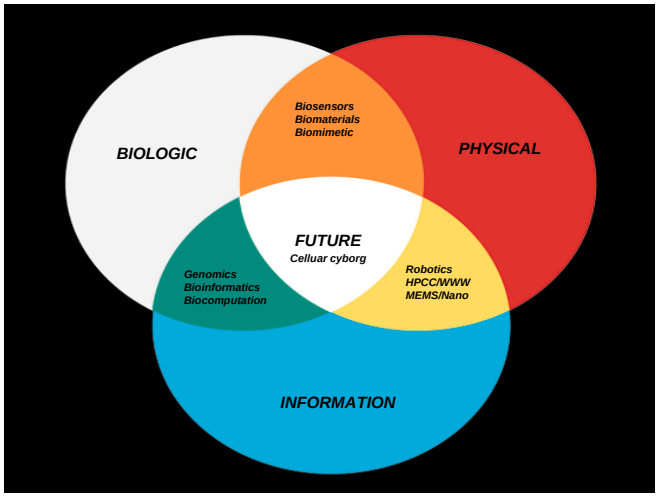
Trends with a lower potential impact, which are more certain are:
- Further use of Minimally Invasive Surgery
- Use of Robotics

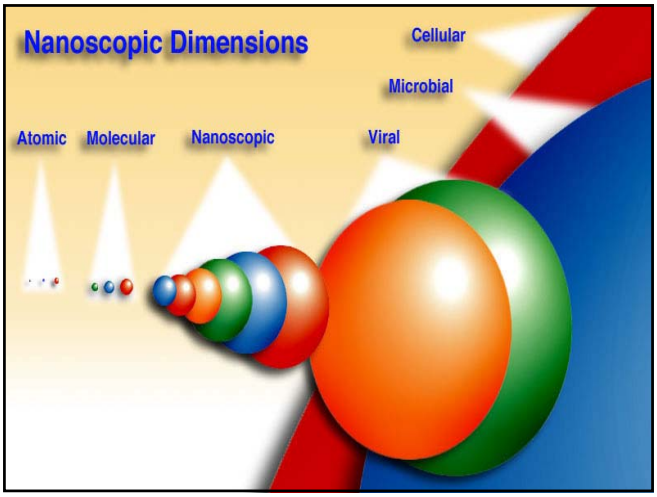
Low Impact High Uncertainty

Trends with a lower potential impact, which are more uncertain are:
- Use of stem cell technology to regrow body parts and repair injury
- (Re-) Emergence of "exotic" disease

Design services taking into account the broader trends and changes







Technology Trends

Devices are smaller (micro to nano), hence

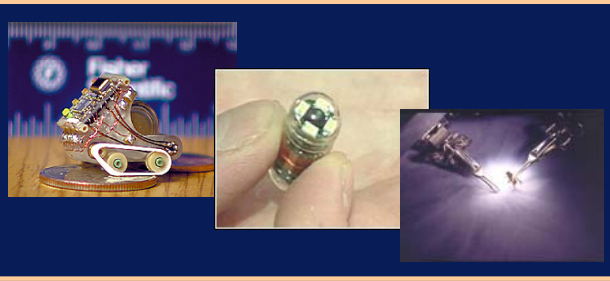
- Cheaper
- Less power
- Ubiquitous
- Transparent (to user)
- Local intelligence

Beginning of a new era

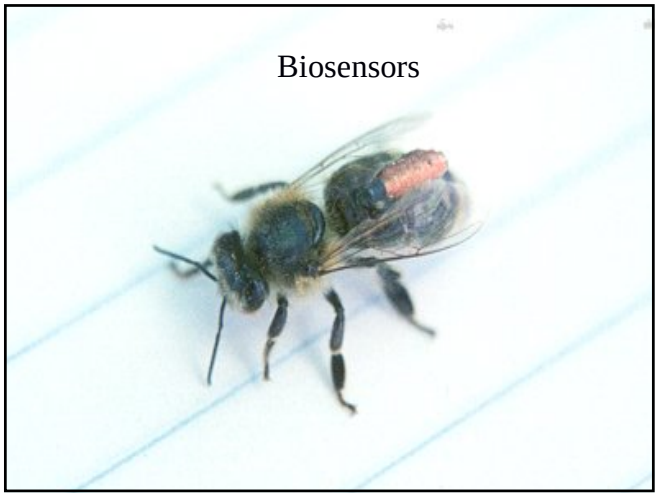
Multiple areas of opportunity

No one else in the field to date

Biomimetic Micro-robot



Biosensors



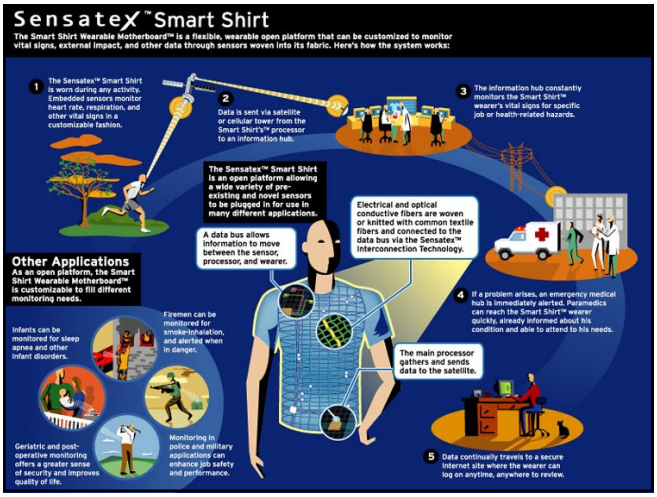
BSN needs in Health Care delivery?

- Diagnosis of Disease
- Monitoring in Acute (Hospital) Setting
- Monitoring of Chronic Disease (at Home)
- Monitoring of Vulnerable Patient Groups

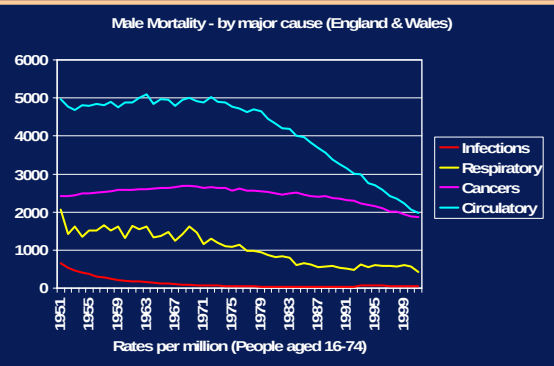
Evolution of Diagnostic Tools

The stethoscope

ECG



Premature mortality rates are falling



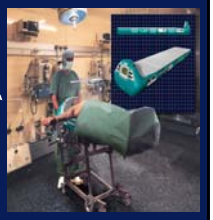
BSN needs in Health Care delivery?

- Diagnosis of Disease
- Monitoring in Acute (Hospital) Setting
  - Acute Illness
  - Post-operative surgical monitoring

The Smart Operating Table

Life Support for Trauma and Transport

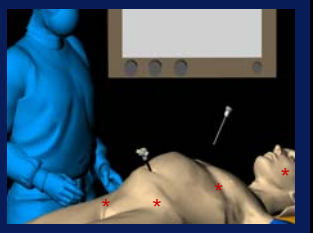
- Defibrillator
- Ventilator
- Suction
- Monitoring
- Blood Chemistry Analysis
- 3-Channel Fluid/Drug Infusion
- Data Storage and Transmission
- On-board Battery
- On-board Oxygen
- Accepts Off-Board Power and Oxygen



Courtesy of Integreated Medical Systems, Signal Hill, CA

The Surgical Command System

- Suction
- Monitoring
- Blood Chemistry Analysis
- 3-Channel Fluid/Drug Infusion
- Data Storage and Transmission
- Accepts Off-Board Power and Oxygen
- Monitors Urinary Output



Electronic Implants

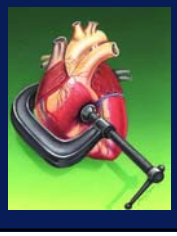
- Some current electronic medical implants are cardiac devices that can keep a heart beating regularly and cochlear implants that can restore hearing.
- The VeriChip for example is a miniaturized RFID chip about the size of a grain of rice that is designed to be implanted under the skin.

The tiny implantable VeriChip contains an ID number that can be used to access personal identity and medical information in an emergency.

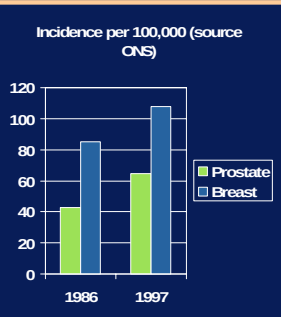
- Each VeriChip contains a unique verification number, that can be read when a proprietary scanner is passed over the implanted chip
- The VeriChip data can be used in conjunction with a database to access needed data, such as to provide hospital emergency room personnel with health information about an unconscious patient
- Future applications could include access control for secure facilities, personal computers, cars and homes, as well as to authenticate users for ATM and credit card transactions
- Brain implants exist for Parkinson's disease and paralysis. Companies like Neural Signals have built products like the Brain Communicator. But their use is still debated by medical ethicists

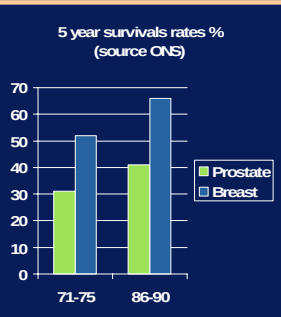
BSN needs in Health Care delivery?

- **Diagnosis of Disease**
- **Monitoring in Acute (Hospital) Setting**
- **Monitoring of Chronic Disease (at Home)**
  - Hypertension
  - Diabetes
  - Ischaemic Heart Disease



More people "living" with fatal illness





Population is ageing with looser social structures

Over 60s
31% by 2021

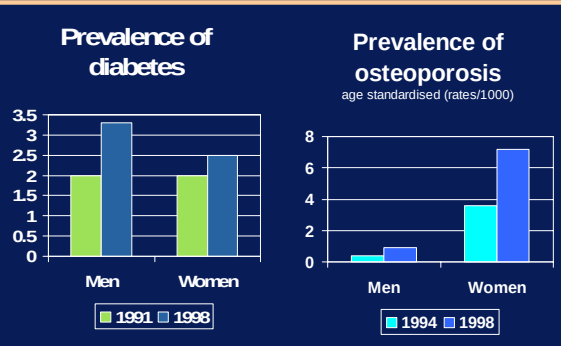
Over 75s
27% by 2021.

Family size
Single Parent Households grow

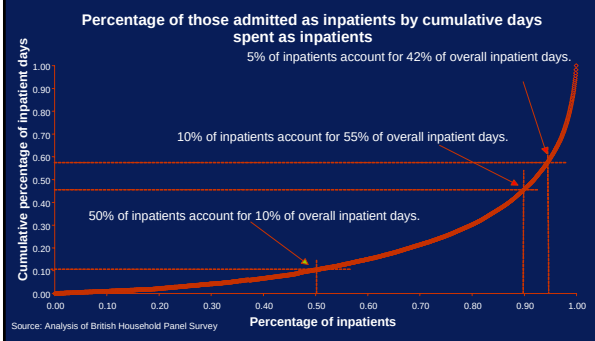
Changing burden of disease

A shift from acute to chronic disease

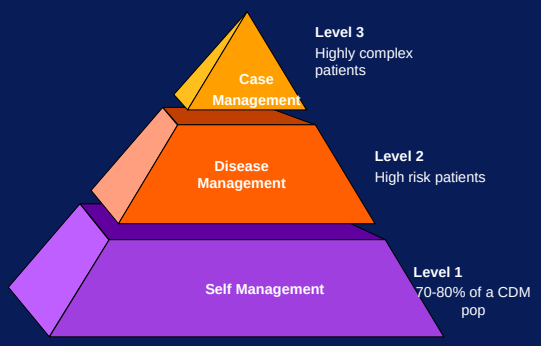
Chronic disease is increasing



Chronic disease management targets the patients that use disproportionate amount of health care resources



Chronic disease management



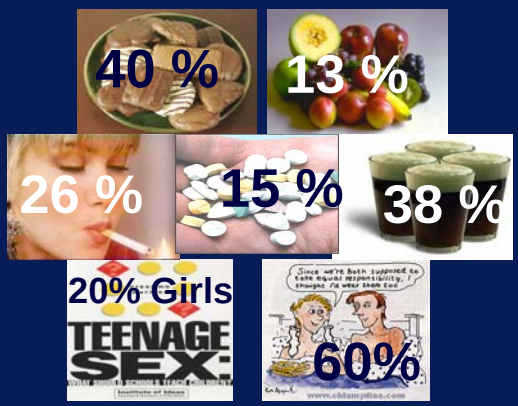
BSN needs in Health Care delivery?

- Diagnosis of Disease
- Monitoring in Acute (Hospital) Setting
- Monitoring of Chronic Disease (at Home)
- Monitoring of Vulnerable Patient Groups
  - Elderly (general well-being)
  - People with disability
  - Life Style changes

Current lifestyles present major risks

60% current burden disease can be attributed to lifestyle factors

Risk taking - current behaviour



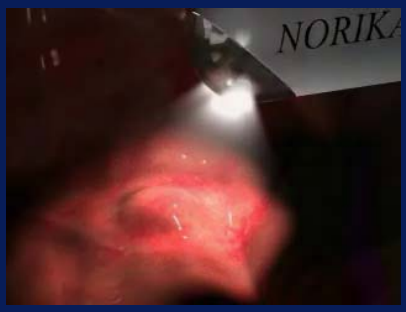
Sensor Placement

- On-Body Sensors
  - External
  - Internal
    - Subcutaneous
    - Luminal cavities
    - Extra-luminal cavities
- Monitoring Environments
  - Home
  - Clinic
  - Hospital

External

- **Motion Analysis**
  - Gait
  - Location
  - Wellbeing

Internal : Body Cavities Capsule Endoscopy

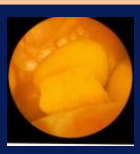


Sensor is Swallowed by the patient

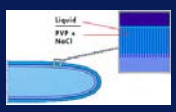
Transmits information to base station

Most useful for visualising small bowel

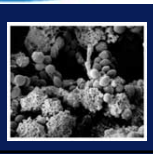
Internal/Acute : Body Cavities Bladder



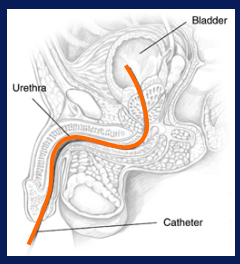
Visual Image



Electrolytes

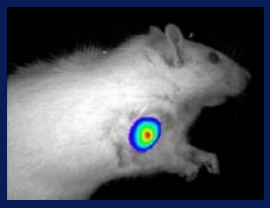


Urinary Catheter Tip



Urinary Infection

Nano-particles Sensors & Cancer



- **Ability to monitor tumour enlargement**
- **Assess degree of response to chemotherapy**

Challenges Faced by BSN in Health

- Development of better sensors
- Improving wireless networks
- Using the wealth of information
- Demonstrating that this technology reduces cost & improves patient care

The Voyage goes on!

Thank You

GZ Yang,
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Benny Low