Building a circular economy for healthcare products

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Scope 1 & 2 emissions

Scope 3 emissions
Medical goods and the operating theatre
The operating theatre

- Operating theatre most resource intensive area of hospital
  - 21-30% of total waste
  - 3-6 times higher energy consumption

- Typical operation is 150-170 kg CO₂
  = driving from London to Edinburgh in a petrol car

- Hotspots (from our systematic review)
  - Energy use
  - Anaesthetic gases
  - Consumable equipment

MacNeill et al. Lancet Planet Health 1(9):e381–8
Production single-use equipment
Decontamination
Waste

68% of carbon of products used is due to single use products
Carbon footprint of different approaches to hysterectomy

Carbon footprint of cataract in different settings

- Cataract operation in UK = 182 kg CO₂
- Cataract operation in India = 6 kg CO₂

- Highly efficient systems
- Reuse of equipment
- Lower rates of infective endophthalmitis

Market dynamics of medical goods
Low cost/complexity products (high volume)

High cost/complexity products

$p300bn$ industry

Smith BD. Brand Therapy. 2018: Practical, Inspiration Publishing
https://www.drugwatch.com/manufacturers/
High cost products

• Complex and multicomponent
  – High embedded carbon
  – Recycling difficult or impossible, and of low priority

• Restricted or limited number of uses
  – Regulatory restrictions on reuse / infection
  – Economic drivers
Low cost: free market economics
Low cost: free market economics

Low cost: outsource production
43% workers took out a loan to pay recruitment fees, averaging over $2,000, which took 11.7 months on average to repay.

47% felt unable to leave their employment due to contractual or other restrictions.

Workers worked an average of 12 hours a day.

10% reported receiving no days off on average in the last three months, 31% had just one day off per month.
Country of origin
ITUC ranking ≥4

45% data unavailable

All health contracts SE Norway: 2015-16
(>29,000 items)
Reuse
Reuse has lower financial and carbon costs

• Example
  – Single use scissors: 835g CO$_2$e/use, £4.26/use
  – Reusable scissors: 64g CO$_2$e/use, £1.43/use

• Systematic Review: 22 studies of single use versus reusable surgical or anaesthetic equipment, all but 2 favour reuse

• Experience suggests in almost all cases reuse saves money

Rizan C et al, in press
Drew et al, 2021
Why is everything disposable?

• At the point of use
  – Perceived or uncertain risk of infection
  – Convenience / lack of relevant infrastructure

• System challenges
  – Regulatory challenges
  – Financial structures that support a linear economy
  – Lack of guidance on infection risk
Infection risk: precipitating circumstances
Precipitating circumstances: surgical instruments

1990s

Inconsistent or inadequate sterilisation

CJD prion disease

Precipitating circumstances: surgical instruments

2020s

Robust decontamination & sterilisation

Standards and quality assurance

HTM 0101
Precipitating circumstances: surgical textiles

“Drapes and gowns must be made of impervious materials. Thin cotton drapes and gowns have no place in orthopaedic surgery”

2014 Consultant Advisory Book

• Knee arthroplasty (>80,000 per annum)
  – 11 drapes/gowns, 14.5kg CO₂ = driving around 72 miles in an average UK car

• Carpal tunnel (>45,000 per annum)
  – 3 drapes/gowns, 5.8kg CO₂ = driving around 21 miles in an average UK car
Precipitating circumstances: surgical textiles

- Single use: typically non-woven petrochemicals (plastic) made overseas
- Reusable: typically woven high-density petrochemicals, reused 75 times
- cotton is obsolete
- Re-useable textiles have typically less than one-third carbon of disposable
Precipitating circumstances: surgical textiles

• All health textiles must meet EN13795 standards throughout the lifecycle

Liquid penetration

Microbial penetration
Precipitating circumstances: surgical textiles

- **Tensile strength**
  - 4x higher with reusable
  - 10x higher if wet

- **Burst**
  - 10x lower with reusable

- **Linting (particle release)**
  - 8x lower with reusable
Precipitating circumstances: surgical textiles

Robust decontamination & sterilisation

Standards and quality assurance

HTM 0104
Infection risk: Perpetuating factors
Gloves: personal misconception

• Glove volumes
  – >1.7 billion/annum in NHS prior to the pandemic, single-use plastic
  – If placed end to end would almost stretch to the moon

• Most glove use (2/3rds) is inappropriate
  – Only required when expected contact with potentially infected bodily fluids or broken skin
  – Inappropriate use may be perpetuated by individuals, hospitals, or even government
Ear microsuction: institutional misconception

- >330,000 procedures performed in England per year (HES data)
- Large variation in practice in the equipment used

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Use routinely</th>
<th>Carbon footprint (g CO$_{2e}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single use sucker</td>
<td>100% (n=18)</td>
<td>3.6</td>
</tr>
<tr>
<td>Gloves</td>
<td>83% (n=15)</td>
<td>25</td>
</tr>
<tr>
<td>Apron</td>
<td>16% (n=3)</td>
<td>65</td>
</tr>
<tr>
<td>Gauze to clean sucker</td>
<td>66% (n=12)</td>
<td>2.1</td>
</tr>
<tr>
<td>Plastic tubing</td>
<td>28% (n=5)</td>
<td>130</td>
</tr>
<tr>
<td>Suction canister lining</td>
<td>6% (n=1)</td>
<td>78</td>
</tr>
</tbody>
</table>

85 fold increase in carbon
Skin contact: institutional misconception

- Single use tourniquets, blood pressure cuffs
- Single use pulse oximeters (USA)
- Single use door handles
Tracheostomy tubes: regulatory restrictions

• Becomes an indwelling device after 28 days so must be replaced
Endoscopes: financial drivers?

“The single-use rhinolaryngoscope eliminates the serious potential risk of prion transmission in ENT endoscopy”

Mistry et al, 2020

“there are no known cases of vCJD being transmitted by surgical instruments or endoscopes”

Health Technical Memorandum 01-06
Electrosurgical products: financial drivers?

Sterility is quality assured
Failure rates are less than those of new products

USA in 2020 >31 million devices were remanufactured
Questions
Questions

• Healthcare staff attitudes and behaviours towards reuse
  – Preliminary work started (MRC Grant)

• Perceived infection risk
  – Infection control guidance (Prof Jennie Wilson)

• Infrastructure and architecture of healthcare
  – Enabling infrastructure such as sterilisation and laundry
  – Cost including annualized budgets

• Industry perspectives
  – Regulatory restrictions
  – Economic models of purchase and supply (servitisation)