Life cycle approaches in the pharmaceutical and healthcare sector

ERM

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About me

- Doctorate: LCA and LCC of bioenergy in UK
- Consultant at ERM since November 2014
- Manchester office
- Product Sustainability team
- LCA & CF
- Many sectors but increasingly pharma focus
- Seconded to AstraZeneca since 2015
ERM – Shaping a sustainable future with the world’s leading organizations

50
Years of innovative sustainability

~1B$
Revenue/y

170+
Counties & territories worked in over the last three years

160
Offices around the world

5500+
Employees across the world

50%
of the Fortune 500 choose ERM as their EHSS partner
Background

- The Sustainable Healthcare Coalition (SHC) – English National Health Service (NHS), pharma companies, ERM
- Product Sustainability team has been working with the SHC for a decade
- Published guidance
  - GHG Protocol Product Standard Sector Guidance
  - Care Pathways Guidance
- Published case studies using the guidance

We have developed relationships with individual members of the SHC and our reputation has led to work with non-member pharma companies.
Drivers

- Health care sector – 5.5% of national carbon footprints
- Pressure on healthcare services to meet government targets
- e.g. NHS aims to be carbon neutral by 2045, no procurement from less ambitious suppliers 2030
- LCA results used in procurement process – competitive advantage, marketing

Rising global GHG emissions are causing climate change

Healthcare is a significant contributor to GHG emissions

There is a vicious cycle between climate change and health
Background

AstraZeneca’s ‘Ambition Zero Carbon’ strategy to eliminate emissions by 2025 and be carbon negative across the entire value chain by 2030

Published 22 January 2020

Novartis announces ambitious ESG targets to increase access to medicines and achieve full carbon neutrality

- Back to News Archive

Sep 01, 2020

GSK sets new environmental goals of net zero impact on climate and net positive impact on nature by 2030

03 November 2020

For media and investors only

Released: London, UK
Simplified Life Cycle

- Active pharmaceutical ingredients (APIs)
- Excipients and formulation
- Device
- Distribution and storage
- Packaging
- Use
- End of life
API

Active pharmaceutical ingredients (APIs)

Excipients and formulation

Device

Use

Distribution and storage

Packaging

End of life
Example product types where this life cycle stage can be significant:

- Tablets
- Capsules
- Dry powder inhalers (DPIs)
- Biologics and vaccines
- Oral suspension powders

Issues:

- Manufacturing type varies incl.
  - Organic small molecule
  - Biologics
  - Plant or animal derived

  High GHG per kg - typical range 100s – 10,000s kg CO₂e/kg though used in small volumes

- Solvents and their incineration
- Catalysts – resource depletion
- Energy used in manufacturing

Potential solutions:

- Don’t waste API
- Green chemistry
  - Energy and material efficiency
  - Solvent and catalyst recycling
  - Bio-solvents
  - Reduce # reaction steps & improve yields
- Renewable energy
Excipients and Formulation

- Active pharmaceutical ingredients (APIs)
- Excipients and formulation
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- End of life
Excipients and Formulation

Example product types where this life cycle stage can be significant:

- Pressurised metered dose inhalers (pMDIs)

Issues:
- Production of F-gases
  - Climate change
  - Ozone depletion
  - Resource depletion

Potential solutions:
- Capturing fugitive F-gases during production
- Replacing high-GWP F-gases with low-GWP alternatives
- Transition - inhalers that don’t require F-gases (e.g. dry powder inhalers)
Device and Packaging

- Active pharmaceutical ingredients (APIs)
- Excipients and formulation
- Device
- Packaging
- Use
- Distribution and storage
- End of life
Device and Packaging

Example product types where this life cycle stage can be significant:

- Pressurised metered dose inhalers (pMDIs)
- Injector pens
- Dry powder inhalers (DPIs)
- Blister packs, foil pouches and sachets

Issues:
- Energy use in assembly (HVAC and sterilisation)
  - Climate change
- Fugitive F-gas emissions
  - Climate change
- Stainless steel parts
  - Ecotoxicity
  - Resource depletion
- Aluminium parts
  - Resource depletion

Potential solutions:
- Renewable energy
- Capturing fugitive F-gases
- Lightweighting
- Recycled materials
Distribution and Storage

Example where this life cycle stage can be significant:

Issues:
Distribution only tends to be significant if air freight utilised

Potential solutions:
Replacing air freight with sea/rail freight

Air freight
Use

Example where this life cycle stage can be significant:

- Patient travel
- Delivery

Pressurised metered dose inhalers (pMDIs)
Gaseous anaesthetics

Issues:
- Patient travel to collect prescription or to have drug administered
- Delivery of prescription to patient
- F-gas emissions

Potential solutions:
- Multipacks
- Encourage delivery
- Electric vehicles
- Capture anaesthetics
- Replace high-GWP F-gases with low-GWP F-gases
- Alternatives (DPIs, intravenous anaesthetics)
End of Life

Active pharmaceutical ingredients (APIs)

Excipients and formulation

Device

Use

Distribution and storage

Packaging

End of life
End of Life

Example where this life cycle stage can be significant:

Pressurised metered dose inhalers (pMDIs)

Issues:

F-gas emissions
Incineration of device and packaging

Potential solutions:

Take-back schemes
Replace high-GWP F-gases with low-GWP F-gases
Alternatives (DPIs)
Increase recyclability
Bio-plastics
Challenges

Data collection
- Complex supply chains (outsourcing)
- Characterising complicated starting materials
- Allocating utilities
- Confidentiality

Patient travel
- Distance
- Modes
- Allocation between purposes

Pharmaceuticals in the environment (PiE)
- UseTox characterisation of complex APIs
- Metabolites
- How much ends up in the environment?

Other
- Single-use plastics
- Regulations stifle design innovations to on market products
- Messaging (e.g. cancer toxicity)
Novartis Case Study

- Novartis’ new Breezhaler® device
- Pressurised metered dose inhalers (pMDIs) contribute due to HFA gases (3% of NHS carbon footprint)
- Novartis wished to examine the carbon footprint benefits of its technology and compare Breezhaler® against competitor devices with a similar function
- Potential advantages in marketing and sales globally
  - Low impact products are easier to market in a new environmentally-conscious world
  - Provide a competitive advantage over similar products with higher impacts
  - Win large contracts with healthcare providers
- Insight into a product’s environmental hotspots, showing areas where work on product design can be focused further to reduce the impact

<table>
<thead>
<tr>
<th>Breezhaler®</th>
<th>pMDI</th>
</tr>
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<tbody>
<tr>
<td>- No HFA gas used</td>
<td></td>
</tr>
<tr>
<td>- Refillable</td>
<td></td>
</tr>
<tr>
<td>- Mainly plastic</td>
<td></td>
</tr>
<tr>
<td>- Optional digital companion</td>
<td></td>
</tr>
<tr>
<td>- HFA gas used</td>
<td></td>
</tr>
<tr>
<td>- Single-use</td>
<td></td>
</tr>
<tr>
<td>- Plastic casing and aluminium canister</td>
<td></td>
</tr>
</tbody>
</table>
Data collected for all inputs and outputs from each stage of the production life cycle

Data included information on materials, energy use, locations and waste streams

FU – 1 month of inhaler use
Results

- Results were extracted for four geographies (UK, Germany, France, Japan) - only UK results are shown below

Device breakdown (monthly use)
Comparisons with Similar Products

- Data for other inhaler products were taken from literature sources.
- This table compares products excluding API (not included in some studies), with the Novartis devices highlighted and showing their impact to be small.
- Other DPI devices have a low footprint, far exceeded by those of pMDI products.
Publications Timeline

- Case study published on Novartis’ website
- Study expanded to LCA, third party reviewed
- Meta-analysis and exacerbation study in preparation
- Paper presented at the Drug Delivery to the Lungs conference
- Paper accepted at the International Primary Care Respiratory Congress
- Paper accepted at the European Respiratory Society congress
- Abstract submitted to the American Respiratory Society conference
- Paper in preparation to submit to ‘Sustainability’
Pharma: Environmental Benefits

Figure 2 | Percentage of Companies in Different Sectors That Believe Their Products Have Positive GHG Impacts

Health Care
Consumer Staples
Financials
Consumer Discretionary
Materials
Information Technology
Energy
Industrials
Utilities
Telecommunication Services

Source: 2014 CDP Climate Change Questionnaire (total of 1,793 companies surveyed).
Care Pathways

- Care pathway = interventions in a patient’s care
- Working with the Sustainable Healthcare Coalition, ERM has written guidance for assessing the carbon, water and waste impacts of care pathways
- Care pathways can be broken down into modules. For example:

  GP visit x5 + ED visit x2 + Surgery x2 + Bed day x6 = Care pathway

- The impact of each module assessed to create impact factors
- Module factors can be used as building blocks to assess patient care pathways
- Allows patient care pathways to be compared with alternative pathways
Adherence and Carbon

- Intervention to improve adherence -> improve typical patient care pathways
  -> fewer emergency admissions, surgical interventions and hospital bed days etc.
- This leads to a carbon saving which offsets impact of intervention

Example:

- In this case, increased adherence leads to a saving of ~219 kg CO₂ e.
- How would this compare with the carbon footprint of a pharma product itself?
- Would there be an overall saving in carbon emissions?

• Using life cycle assessment (LCA), ERM can quantify these environmental benefits
Smart Inhalers

- Regular inhalers enhanced with either built in or clip-on “smart” functionality
- Device records inhaler use by patient

**Potential benefits**
- Helps patient to adhere to proscribed inhaler routine
- Allows medical professionals to monitor adherence
- Increased adherence leads to improved patient outcome
- Consequent reduction in:
  - emergency admissions
  - surgical intervention
  - wasted inhalers

**Potential negatives**
- Life cycle environmental impacts of the device
  - Device production
  - Device disposal
- Additional cost

- Do the benefits of the smart inhaler outweigh the device’s carbon impact?
Smart Inhalers LCA

• Produced by Adherium
• SmartTurbo combines with AstraZeneca’s Symbicort Turbuhaler

• Functional unit:
The annual management of a child with asthma aged 6 to 16 years old in the United Kingdom, taking regular inhaled steroids, typically with poorly controlled asthma
Paediatric asthma – Care pathway

Inputs
- Energy
- Water
- Pharmaceuticals
- Consumables
- Equipment

Paediatric asthma → Self management → Exacerbation

Outputs
- Waste - Clinical/ non clinical
- Waste - Devices/ inhalers
- Wastewater
- Emissions
- Pharmaceuticals

Additional Steps:
- ED visit
- Ambulance
- GP visit
- Hospital admission
- Oral steroid treatment

Key Terms:
- Self management
- Exacerbation
- ED visit
- Ambulance
- GP visit
- Hospital admission
- Oral steroid treatment

Other Key Terms:
- Waste
- Wastewater
- Emissions
- Pharmaceuticals

Life Cycle Network 2021
Results

GHG emissions (kg CO2-eq/year) - 56%

Water consumption (m³/year) - 65%

Waste Produced (kg/year) - 29%

- Self management: long acting inhalers
- Self management: short acting inhalers
- Patient travel to GP
- GP consultations
- Patient travel to A&E
- A&E visits

- Oral steroids
- Hospital admission: inpatient episodes
- Hospital admission: day-case episodes
- Hospital admission: intensive care unit
- Ambulance for hospital admissions
Concluding Remarks – Care Pathways

- The net environmental benefits of healthcare products can be quantified by comparing care pathways.
- Care pathways guidance allows for the impact of patient treatment to be assessed.
- Improved adherence can improve the environmental impact of care pathways.
- This can offset the environmental impact of devices such as smart inhalers.
Thank you

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References

1. IND/MF and IND/GLY/MF Inhaler Carbon Footprint Technical Report


Photo sources

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