Cost analysis and environmental impact estimation of polypropylene iodine contrast media containers compared with glass containers: A UK hospital perspective

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BACKGROUND

- Globally, the use of computed tomography (CT) is on the rise[1] due to the increasing prevalence of chronic diseases, including cancer and chronic respiratory disease[2]
- In England, the number of scans performed has nearly doubled over the past decade, from ~3.5 million in 2012–2013 to 6.7 million in 2021–2022[3]
- Iodine contrast agents (CAs), used to improve imaging resolution in CT, are available in glass or polypropylene packaging
- Traditional glass containers for CAs are associated with safety issues and high costs of waste disposal[4,5]
- Introducing polypropylene containers for CAs can reduce sharps injury rates,[4] disposal waste costs,[6] and environmental impact,[7] compared with glass containers
- To gain further insights on the differences between glass and polypropylene containers for CAs, and support informed decision-making, we estimated the economic and environmental impact of switching from glass to polypropylene (+PLUSPAK™) containers over 3 years from a UK hospital perspective

METHODS

- A cost calculator was developed in Excel® to compare the economic, clinical, and environmental impact of +PLUSPAK™ and glass containers, from the perspective of a UK hospital consuming, on average, 3,492 containers annually (all sizes, base-case scenario)
- The following outcomes were assessed:
  - Environmental:[7] Climate change, ozone depletion, human toxicity, photochemical oxidants, particulate matter, ionising radiation, ecosystems, resources, and cumulative energy demand
  - Clinical:[5] Incidence of sharps-related injuries and staff time lost managing injuries
  - Economic: Cost of sharps-related injury management,[5,8,9] waste disposal,[10–14] and CA wastage;[4,9] resource use measured in terms of CA wastage due to breakages[4] and weight of waste disposed
- The estimated progressive adoption of +PLUSPAK™ was 0% in the base case scenario, and 50% at Year 1, 75% at Year 2, and 100% at Year 3 in the revised scenarios
- One-way sensitivity analyses (OWSA) were run to assess the impact of parameter uncertainty (±20%) on the budget impact
- When publicly-available data were not available, internal data from GE HealthCare were used[10,11]
- Key assumptions included:
  - The model used the National Health Service (NHS) list price cost per bottle, which may not capture any discounts agreed between the provider and the hospital[15,16]
  - Media wastage calculations were specific to wastage due to bottle breakages and did not reflect other means of wastage
  - The environmental impact was calculated based on the impact of 100 mL bottles, and increases proportionally for larger bottles sizes based on the weight difference between the larger bottles and the 100 mL bottle

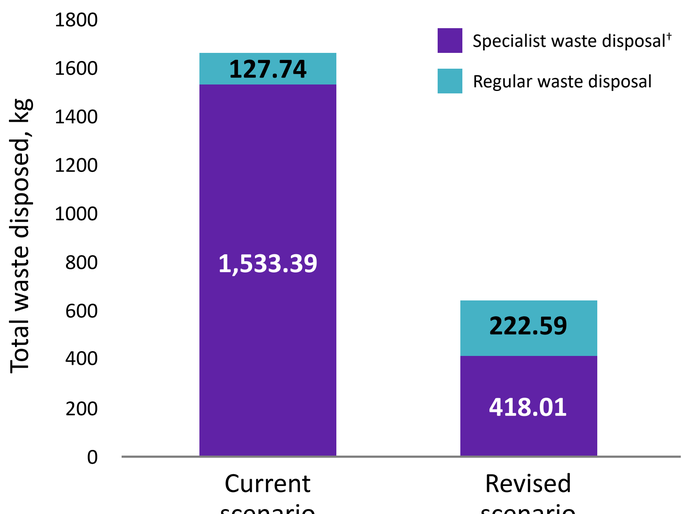
RESULTS

- Results were provided by material (glass vs +PLUSPAK™) and by volume (100 mL vs 200 mL vs 500 mL +PLUSPAK™ containers)
- **Over 3 years, fully switching to +PLUSPAK™ was estimated to result in:**
  - A ~70–75% reduction in environmental impact (**Table 1**)
  - A 1,115.38 kg reduction in specialist waste disposed (**Figure 1**) and a 13,432 mL reduction in CA waste
  - A 75.0% reduction in sharps-related injury incidence (from 25.11 in the current scenario to 6.28 in the revised scenario over 3 years) and 32.25 hours less staff time spent managing these injuries
  - An estimated cost difference of £65,383 (−6.1%) in overall spending, driven by savings from:
    - *Acquisition:* −£52,475.96
    - *Sharps-related injury management:* −£8,789.65
    - *Specialist (sharps or hazardous) waste disposal:* −£3,558.05
    - *Breakage cleanup:* −£647.7

Table 1: Total environmental impact after implementation of PLUSPAK™ over 3 years in the revised vs current scenarios, and % change in each metrics relative to the current scenario

Metric	Total (over 3 years)		Change (revised vs current)
	Current scenario	Revised scenario	
Climate change (kg CO2eq)	32,806.67	8,202.78	**−75%**
Ozone depletion (kg CFC-11eq)	0.00353	0.00104	**−71%**
Human toxicity (kg 1,4-DBeq)	9,076.06	2,572.56	**−72%**
Photochemical oxidants (kg NMVOC)	138.88	39.37	**−72%**
Particulate matter (kg PM10eq)	66.01	17.93	**−73%**
Ionising radiation (kg U235eq)	5,916.24	1,706.23	**−71%**
Ecosystems (species/year)	0.00043	0.00012	**−72%**
Resources (economic units)	172,500.66	52,260.32	**−70%**
Cumulative energy demand (MJ)	576,975.09	173,010.97	**−70%**

Figure 1. Total waste disposed in the current and revised scenario (overall, over 3 years). †Specialist waste is usually sharps or hazardous waste.

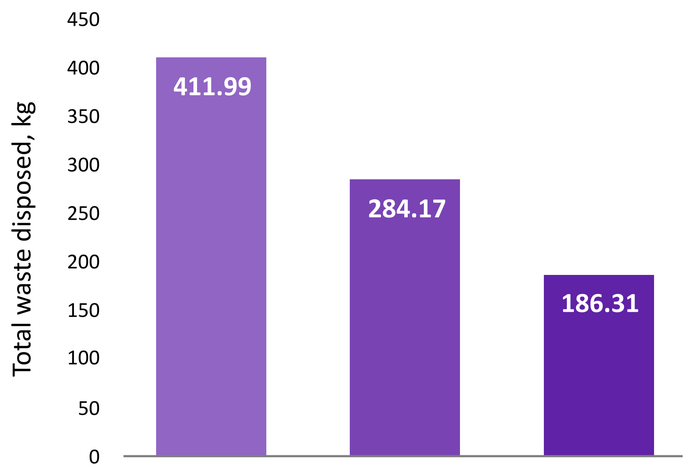


- **Over 3 years, using 500 mL +PLUSPAK™ containers resulted in the lowest:**
  - Environmental impact metric scores (**Table 2**)
  - Total waste disposed (**Figure 2**)
  - Number of breakages (and the least time cleaning up those breakages): 15.4 for 500 mL vs 77.0 for 100 mL and 38.5 for 200 mL containers

Table 2: Total environmental impact after the implementation of 100, 200, and 500 mL PLUSPAK™ containers over 3 years

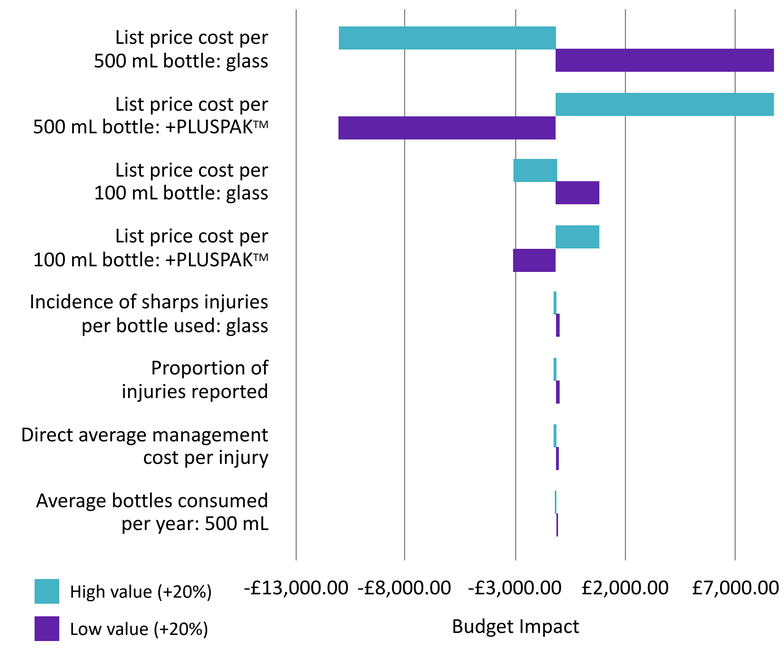
Metric	100 mL	200 mL	500 mL
Climate change (kg CO2eq)	4,343.65	2,996.00	1,964.27
Ozone depletion (kg CFC-11eq)	0.000298	0.000205	0.000135
Human toxicity (kg 1,4-DBeq)	983.88	678.63	444.93
Photochemical oxidants (kg NMVOC)	15.08	10.40	6.82
Particulate matter (kg PM10eq)	4.64	3.20	2.10
Ionising radiation (kg U235eq)	736.34	507.88	332.99
Ecosystems (species/year)	0.0000487	0.0000336	0.0000220
Resources (economic units)	29,610.30	20,423.45	13,390.27
Cumulative energy demand (MJ)	93,244.78	64,314.79	42,166.85

Figure 2. Total waste disposed over 3 years after implementing 100, 200 or 500 mL +PLUSPAK™ containers



- **OWSA results showed that the acquisition cost remained the main driver of budget impact (Figure 3)**

Figure 3. One-way sensitivity analysis results



CONCLUSION

Use of +PLUSPAK™, particularly 500 mL containers, compared with glass containers, can help reduce environmental impact and costs, and optimise staff safety and efficiency in radiology departments, thereby supporting hospitals to achieve sustainability and environmental safety goals[17]

Limitations of the study and replication of the results may depend on the hospital setting. Source of costs included in the model are public. Results are not discounted in the timeframe.

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Abbreviations: CA, contrast agent; CT, computed tomography; NHS, National Health Service; OWSA, One-way sensitivity analysis; UK, United Kingdom.

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Disclosures: MC and AC are GE HealthCare employees. JH, RM and CR have nothing to disclose.