# Robot Pharmoduct® of Dedalus : Feasibility study of the implementation of automated campaigns of chemotherapy preparations

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COM20-93746

## Introduction :

In a context of constant increase in the production activity of chemotherapy, with fixed human means, we have acquired a robot to improve productivity.
To facilitate early production, standard doses (DS) for 19 molecules have been implemented.

## Objective :

Evaluate the feasibility of automated campaigns for the 19 molecules.

## Equipment and Method :

- Development of a tool to assess the robot's production capacities by integrating its own constraints such as :
  - A maximum production capacity of 14 chemotherapy bags
  - A product vial positions limited to 15
  - A product loss of 9 ml per campaign.
- Determination for each molecule and each standard dose : the maximum achievable number of preparations per campaign and the associated additional production costs.
- Establishment of a monthly forecast of the number of campaigns to be carried out, considering the consumption data and the stability of each product.

## Results :

- 69 standard doses were produced and evaluated.
- Average of the maximum number of chemotherapy bags prepared / campaign = 11 [3-14]
- Limiting factors are the number of product vials and volume of the multi-dose-bag equal to 1liter.

| Standard dose | 4800 | | Vol product | 96 | | Vol solvent | 144 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of chemotherapy bag | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Number of vials required | 14,44 | 13,48 | 12,52 | 11,56 | 10,6 | 9,64 | 8,68 | 7,72 | 6,76 | 5,8 | 4,84 | 3,88 | 2,92 | 1,96 |
| Number of vials required (rounded) | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
| Dose in mg required (lossless) | 67200 | 62400 | 57600 | 52800 | 48000 | 43200 | 38400 | 33600 | 28800 | 24000 | 19200 | 14400 | 9600 | 4800 |
| Volume of product required (with loss) | 1353 | 1257 | 1161 | 1065 | 969 | 873 | 777 | 681 | 585 | 489 | 393 | 297 | 201 | 105 |
| Remaining product volume | 147 | 143 | 139 | 135 | 131 | 127 | 123 | 119 | 115 | 111 | 107 | 103 | 99 | 95 |
| Volume product required (lossless) | 1344 | 1248 | 1152 | 1056 | 960 | 864 | 768 | 672 | 576 | 480 | 384 | 288 | 192 | 96 |
| Product loss (euros) | 7,204176 | 7,008144 | 6,812112 | 6,61608 | 6,420048 | 6,224016 | 6,027984 | 5,831952 | 5,63592 | 5,439888 | 5,243856 | 5,047824 | 4,851792 | 4,65576 |
| Volume of solvent required (with loss) | 2034 | 1890 | 1746 | 1602 | 1458 | 1314 | 1170 | 1026 | 882 | 738 | 594 | 450 | 306 | 162 |
| Volume of solvent required (lossless) | 2016 | 1872 | 1728 | 1584 | 1440 | 1296 | 1152 | 1008 | 864 | 720 | 576 | 432 | 288 | 144 |
| Volume of solvent required (with loss tubing) | 2026 | 1882 | 1738 | 1594 | 1450 | 1306 | 1162 | 1018 | 874 | 730 | 586 | 442 | 298 | 154 |
| Volume of solvent required (with loss quality test) | 2024 | 1880 | 1736 | 1592 | 1448 | 1304 | 1160 | 1016 | 872 | 728 | 584 | 440 | 296 | 152 |

Table 1 : exemple of an evaluation of the robot's production capacities for 5FU's diffusers to the DS of 4800 mg

- Due to their short stability, 2 molecules were not considered in the study: Daratumumab and Cetuximab.
- Number of campaigns required to cover 1 month of production = 123 ≈ 6 campaigns / day
- Monthly additional production cost ≈ 47280 €
- 98% of the additional production cost are due to 5 molecules : Bevacizumab, Nivolumab, Pembrolizumab, Rituximab and Trastuzumab.

| Molecules | Additionnal production cost | % of prescription coverage | Stability (in days) | Penibility | Number of campaign / month |
|---|---|---|---|---|---|
| 5 FU bolus | 23,96 | 80% | 28 | Non | 7 |
| 5 FU diffuser | 117,91 | 82% | 14 | Oui | 14 |
| Bevacizumab | 4320,66 | 65% | 28 | Non | 5 |
| Cisplatine | 52,50 | 60% | 28 | Oui | 8 |
| Cyclophosphamide | 87,23 | 72% | 28 | Oui | 8 |
| Cytarabine | 30,55 | 84% | 28 | Oui | 10 |
| Docétaxel | 31,40 | 58% | 28 | Non | 5 |
| Doxorubicine | 33,45 | 76% | 28 | Non | 7 |
| Epirubicine | 19,85 | 78% | 28 | Oui | 4 |
| Etoposide | 13,13 | 23% | 28 | Non | 1 |
| Gemcitabine | 84,35 | 91% | 28 | Oui | 10 |
| Irinotécan | 172,88 | 80% | 28 | Non | 8 |
| Nivolumab | 13956,62 | 80% | 28 | Non | 6 |
| Oxaliplatine | 77,51 | 72% | 28 | Non | 6 |
| Paclitaxel | 149,24 | 57% | 12 | Oui | 6 |
| Pembrolizumab | 23823,85 | 94% | 7 | Non | 3 |
| Rituximab | 3763,78 | 99% | 28 | Oui | 11 |
| Trastuzumab | 521,57 | 68% | 28 | Oui | 4 |
| | | | | | 123 |

Table 2 : Comparative table of the production of the molecules studied

## Discussion :

- This feasibility study allowed us to refine our strategy for the automated production of chemotherapy
- The 5 most expensible molecules → Manually produced under insulator (to limit product losses).
- Optimization of robot productivity → Request of a 2L mother bag creation.
- Less-consumed molecules → Adaptation to the length of series to the consumption (limit losses due to finished products destruction) + To combine the production of several DS au within the same campaign when possible (optimization of the robot loading).
- At last, the tool developed for this study will facilitate the planning of the automated production campaigns by calculating raw material requirements for each campaign according to the series length.