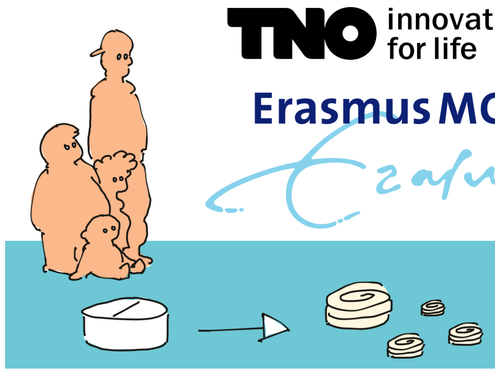

PERSONALIZED MEDICATION USING 3D PRINTING – CASE STUDIES IN AN UNIVERSITY HOSPITAL

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PURPOSE

Problem definition : Current medication is often delivered in forms not suitable for pediatric use, leading to cumbersome and possibly unsafe manipulation of drugs.

Use cases
•**Flecainide** for abnormal heart rhythms in children, where standard 50 mg tablets are not suitable for pediatric patients.
•**Hydrocortisone** for children with adrenal insufficiency (AI), where the current standard of care (SOC) leads to fluctuating cortisol levels, adversely affecting health and quality of life

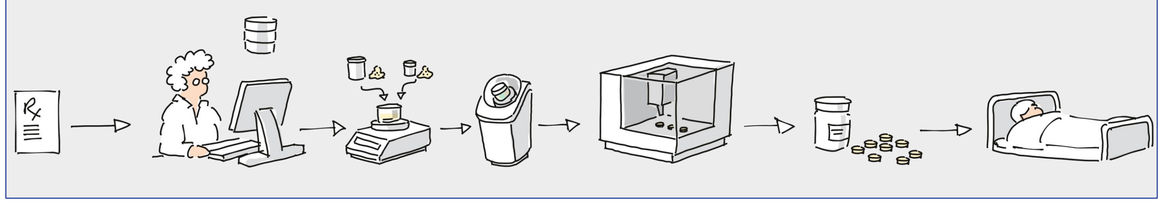
Current solution IV -liquid orally dosed with a syringe/ crushed tablets

OBJECTIVE

The objective of these studies was to develop personalized pediatric medications using 3D printing technology. The first study focused on creating customized flecainide tablets for children with abnormal heart rhythms, while the second aimed to develop sustained-release (SR) hydrocortisone tablets for pediatric patients with adrenal insufficiency(AI).

METHOD

•**Flecainide Tablets**: Researchers used the semi-solid extrusion (SSE) 3D printing technique to create personalized flecainide tablets. A pharmaceutical formulation containing flecainide, poloxamer, and lactose was prepared into a printable paste, with tablets designed using CAD and tested against European Pharmacopoeia (EP) standards.
•**Hydrocortisone Tablets**: A 3D-printed (using both SSE and FDM) sustained-release hydrocortisone tablet was developed for stable cortisol delivery. These tablets were compared with commercial slow-release tablets and manually filled capsules to evaluate release profiles and drug content. SSE printed tablets are still under investigation.



ANALYSIS

Printed tablets are tested in compliance with the European Pharmacopeia standards for conventional-release solid dosage forms, covering the weight distribution, uniformity of content and dissolution properties.

RESULTS

•**Flecainide**: The 3D-printed flecainide tablets met all EP standards, including dosage unit uniformity, content uniformity, mass uniformity, dissolution, and disintegration, demonstrating enhanced dosage accuracy and safety for pediatric use (Fig1&2).
•**Hydrocortisone**: The 3D-printed hydrocortisone tablets exhibited stable release profiles comparable to commercial products, with precise drug content closer to the intended dose. Additionally, manufacturing costs for 3D-printed tablets were significantly lower (Fig 3&4)

Fig 1

Tablet diameter (mm)	*Mean content relative to expected content (%) N=10*	*(%)*	*Relative standard deviation (%)*
5	*104.45*		*1.01*
4	*102.77*		*2.24*
3.5	*102.74*		*2.41*
3	*106.25*		*1.00*

Fig 1: Content Uniformity data of flecainide tablets. (EP 85-115%): None of the tablets have a mean content exceeding 10% relative to the declared content. Also all of the individual contents of each tablet are between 75-125% of the average content. Therefore the batch printed with the final formulation complied with the regulations described in EP2.9.6, indicating uniformity in the content of the 3D printed tablets.

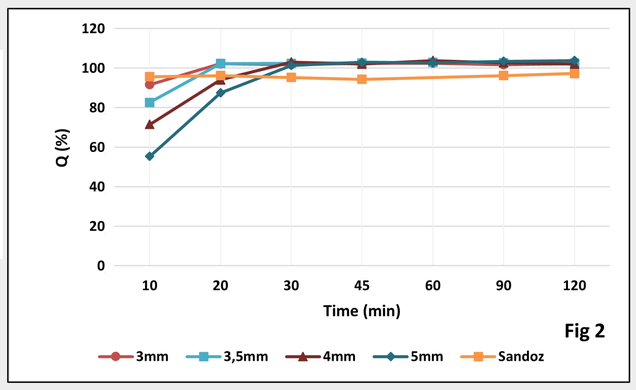


Fig 2

Fig 2: Dissolution properties of flecainide tablets (EP 80% in 45 mins) : Dissolution data of 3; 3.5; 4 and 5 mm diameter 3D printed flecainide tablets and commercially available 50 mg flecainide Sandoz tablet in 500 mL demineralized water.

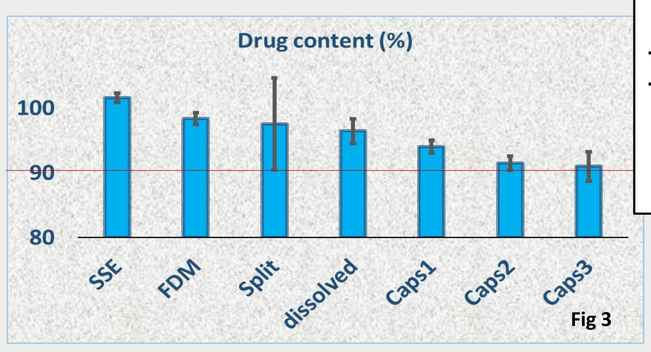


Fig 3

Fig 3: Hydrocortisone content per formulation

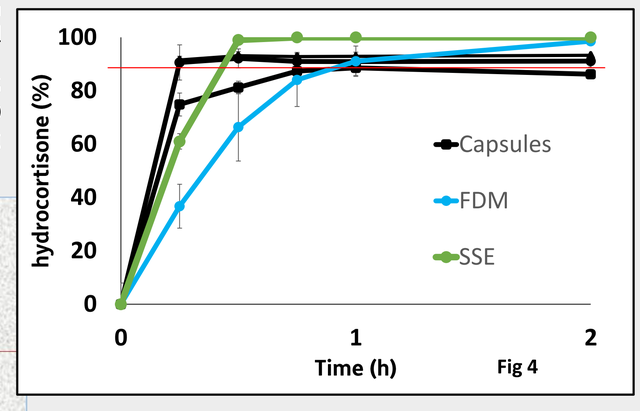
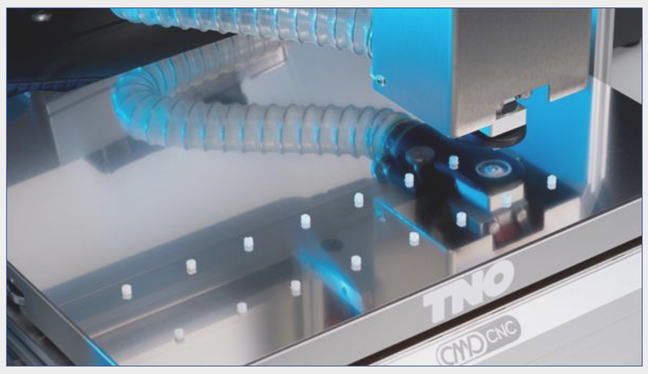


Fig 4

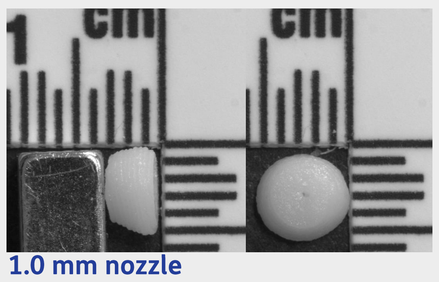
Fig 4: Drug release profiles (%) for compounded hydrocortisone capsules and FDM tablets. E.P recommendation 80% in 45 mins. All formulations comply.

3D Printing of tablets using Fused Deposition Modelling (FDM) printing

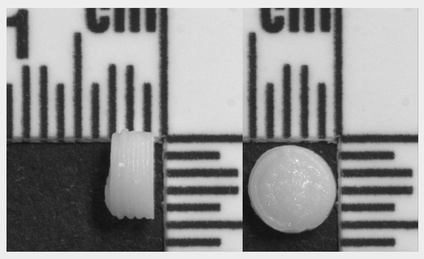


3D Printing Set-up for Semi Solid Extrusion (SSE) printing

Visual appearance



1.0 mm nozzle



0.4 mm nozzle

3D Printed (SSE) tablets

CONCLUSIONS

- ❑ These studies highlight the successful implementation of 3D printing technology for producing personalized pediatric medications.
- ❑ By providing precise, customizable, and cost-effective solutions, 3D printing offers a significant advantage over traditional methods.
- ❑ Future research will focus on expanding the application of 3D printing to other conditions, integrating this technology into clinical practice, and overcoming technical and regulatory challenges to improve patient outcomes in pediatric healthcare.

FUTURE STUDIES

Ongoing studies on hydrocortisone tablets using SSE technology have shown promising results. In our planned patient study at the end of 2024, we will evaluate the acceptance of 3D printed medication, expecting that both children and parents will prefer it, leading to improved adherence and more accurate dosing.

Suitable drug dosage for every child is crucial for adequate treatment

FUNDING
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