3D Printed Medicines: A Digital Pharmacy Era

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Evolution of Technology
A Historical Perspective

1784

1st Industrial Revolution
- Steam
- Water
- Mechanised Production
Evolution of Technology

A Historical Perspective

1st Industrial Revolution
- Steam
- Water
- Mechanised Production

2nd Industrial Revolution
- Division of Labour
- Electrical Energy
- Mass Production

1784 → 1870
A Historical Perspective

Evolution of Technology

1st Industrial Revolution
- Steam
- Water
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2nd Industrial Revolution
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- Mass Production

1784

1870

1969

3rd Industrial Revolution
- Electronics
- IT
- Automated Production
Evolution of Technology

A Historical Perspective

1st Industrial Revolution
- Steam
- Water
- Mechanised Production

2nd Industrial Revolution
- Division of Labour
- Electrical Energy
- Mass Production

3rd Industrial Revolution
- Electronics
- IT
- Automated Production

4th Industrial Revolution (?)
- IoT
- Mass Customisation
- 3D Printing

1784
1870
1969
Now
Current 3D Printing Applications

- Medical Applications
  - Tissue engineering
  - Medical devices & prosthetics
  - 3D Printed Tablets
  - Dentistry

- 3D Printed Tablets

- Dental models

- Tissue engineering samples
Current 3D Printing Applications

- Tissue engineering
- Medical applications
- Dental prosthesis
- Medical devices
- 3D Printed Tablets
The 3 Ds of 3D Printing Medicines

- **Design**
  - CAD software

- **Develop**
  - Excipient selection
  - Printing parameters

- **Dispense**
  - On-site printlet production and dispensing

**Personalised Medicines**
A Need for Personalisation

Differences in:
- Age
- Gender
- Ethnicity
- Comorbidities
- Body type
- Polypharmacy
Motivations for 3D Printing

1. Dose Flexibility
1. Dose Flexibility

Conventional Manufacture

- Mass produced
- Fixed strength
1. Dose Flexibility

3D Printing Medicines

- Variety of strengths
- Dosing accuracy
- Personalisation
Motivations for 3D Printing

1. Dose Flexibility
2. Decentralised Production
2. Decentralised Production
Motivations for 3D Printing

1. Dose Flexibility
2. Decentralised Production
3. Patient Centered Design
3. Patient Centered Design

Choice of:

- Shape
- Size
- Colour
- Flavour
- Formulation Type
3. Patient Centered Design

Patient acceptability of 3D printed tablets

Patient reported outcome (PRO)

Post-swallowing

Shapes

- Sphere
- Torus
- Disc
- Tilted
- Capsule

Participants (%)

0 20 40 60 80 100

Extremely comfortable
Somewhat comfortable
Neither comfortable nor uncomfortable
Somewhat uncomfortable
Extremely uncomfortable

5
4
3
2
1

Extremely comfortable

Not comfortable
Motivations for 3D Printing

1. Dose Flexibility
2. Decentralised Production
3. Patient Centered Design
4. Unique Dosage Forms
4. Unique Dosage Forms

Polypills
4. Unique Dosage Forms

Personalised Polypills
4. Unique Dosage Forms

Personalised Polypills
4. Unique Dosage Forms

Fast-dissolving Printlets

- Immediate release
- Orally disintegrating in ~2 seconds
Improved Patient Outcomes

Paediatrics and Geriatrics

Complex Regimes

Tailored dosage forms

✓ Improve medication adherence
✓ Improved efficacy
✓ Reduced side effects
Our Vision... A Digital Pharmacy

- Therapeutic Need
- Digital Prescription
- Digital Design
- 3D Printer
- Personalisation
- Administration
FDA-Approved 3D Printed Tablet

Spritam® (levetiracetam): Aprecia Pharmaceuticals

Well-defined niche; High-dose (250, 500, 750 & 1000 mg) Oro-dispersible tablet
Conclusion

• 3DP could cause a paradigm shift in pharmaceuticals
• Don’t judge the technology from the early manifestations
  – We are required to come together!

Review

3D Printing Pharmaceuticals: Drug Development to Frontline Care

Sarah J. Trenfield,1 Atheer Awad,1 Alvaro Goyanes,2 Simon Gaisford,1,2 and Abdul W. Basit1,2,*

Reshaping drug development using 3D printing

Atheer Awad 1,‡, Sarah J. Trenfield 1,‡, Alvaro Goyanes 2, Simon Gaisford 1,2, Abdulk W. Basit 1,2 §,
Thank you!

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