Chyme Reinfusion

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Problem statement

'Design and make a portable device that re-infuses chyme in ileostomy patients, improving their quality of life and ensuring best health outcomes with the view to allow the flexibility for further development in the future.'

Motivation

Ileostomy patients are left with part of their small intestine diverted through the skin at a 'stoma'. The standard of practice is to dispose the chyme (semi-digested food) from the stoma; this atrophies the lower part of the intestine and the patients lose the nutritional content from the chyme.

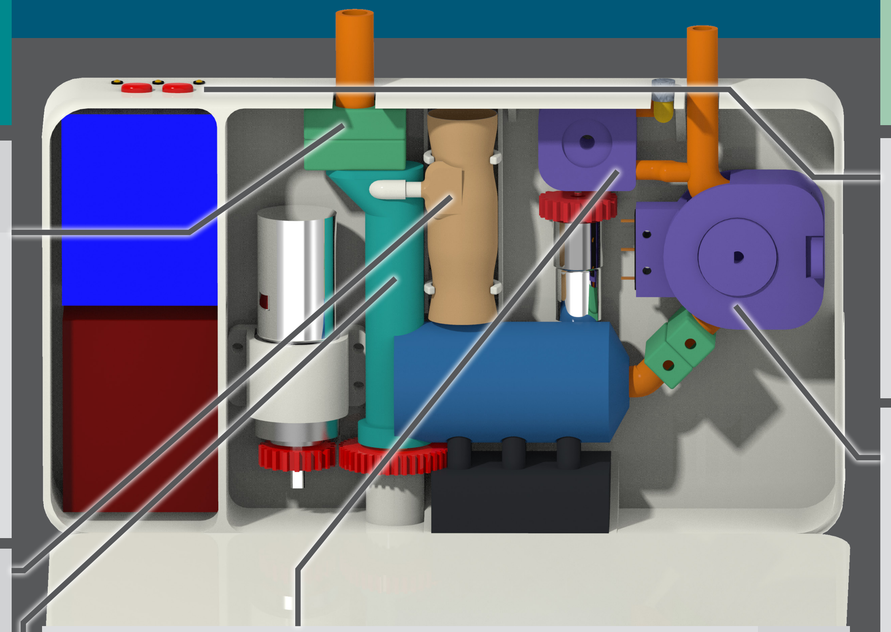
Overall Concept

The device pumps chyme between two stomata through the integration of the subsystems in a compact, discrete and ergonomic configuration. It is portable, incorporates various sensors for monitoring and research purposes, contains a removable, continuous, self-sealing component in contact with the chyme remaining hygienic, provides effective degassing and active chyme detection.

Outcome

The project produced proof of concepts for each of the various subsystems and a to scale model of the envisaged final product. Chyme detection, Degassing, macerating and pumping all showed promise in testing requiring refinement before implementation into a device. A compact casing design was produced incorporating a hinged front panel and set of buttons and LEDs for user interaction.

mass	size	battery duration
250 g	20×10×5 cm	12 hrs
power consumption	**pipes lifetime**	**retail price**
20 W	3 days	£800



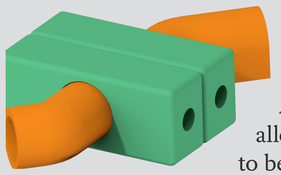
1 Sensors

To control the pumps and macerator.

To take measurements from the chyme for diagnosis or research purposes.

Pump control sensors determines presence of chyme or detects blockage in the tube and instructs pump.

Flow rate sensor counts peristaltic pump revolutions.



A removable section at the intermediate chamber allowing further sensors (pH, sodium or potassium) to be added once developed.

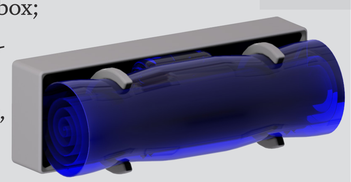
2 Fail-safe mechanism

During operation, the bag is wrapped in the box;

Triggered when sensors detect a blockage anywhere in the system;

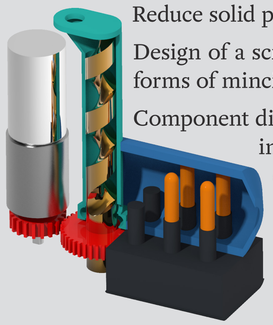
Can also be triggered by excess of pressure, or manually;

Emergency storage of the chyme for ~1 hour.



3 Macerator

internal torque	speed	motor size
0.4 Nm	100 rpm	22×22×57 mm



Reduce solid particle size to below 2 mm for degassing

Design of a screw pump and small exit hole being selected; other forms of mincing, blending and mashing were also considered

Component dimensions with a thin cylindrical part chosen utilising a 11 mm drill bit as the internal screw improving cost and ease of manufacture

Incredibly promising successfully pumping high viscosity mediums yet experienced blockage issues for input particle sizes above 5 mm

4 Degasser

gas removed	max. chyme flow rate
70 %	120 mL/hr

0.2 - 2L of gas is excreted from intestines per day. Including a degassing function minimizes discomfort due to flatulence

Small-diameter tube allows surface tension of water to separate gas bubbles from the chyme. A peristaltic pump with a needle head sucks gas bubbles but not liquid away.

The use of small-diameter tube constrains the maximum size of food particles, which calls for the need for a macerator in the upstream.

5 Pipes

inner diameter	min. blockage frequency
5 mm	20 min

No blockage occurred during our testing period of 20 minutes.*

A majority of blockages can be resolved spontaneously.†

* Tested with porridge and couscous in water. A more viscous fluid further reduces chance of blockage.
† By pumping backwards, or forwards at a higher speed.

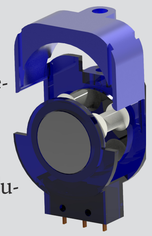
6 Data Transmission/UI

The data we gather will be initially stored on board the device in long term memory. This will regularly push the data to L2S2, which can be displayed to doctors, patients or researchers.

The patient will also be able to interact with the device by way of an ON/OFF button, with several LED's to display if the device is on, battery remaining, blockage status, if the tubing needs changing.

7 Peristaltic pump

flow rate	rotor torque	size
40 mL/min	0.4 Nm	8×7×2 cm



Is the ideal pump to use in the device, it is easy for patients to replace pipes and maintenance.

Rotor driven by a geared motor.

Flexible housing, easy for pipe replacement, and to adjust occlusion, held in place by slots and restricted by screws.

8 Further development

Sampling valve at device chyme output

An automatic blockage clearing function

Sensors: Extended indicator measuring function

Macerator: Investigation of tapered and mono pump

Degasser: Use multiple suction points to improve efficiency. The effect of needle orientation can be investigated. A control unit can be implemented. Gas filter at degassing output.

Pipes: A more thorough testing for more accurate frequency of blockage, with more solid and fluid medium

Peristaltic pump: embedding smaller switches, simpler housing removal mechanism

Acknowledgement

'Team Chyme'

member	weeks	inventions
5	5	∞