Residual Gastric Volume by George's Dye Dilution Method

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Objective

To create an easy and convenient method to obtain an accurate measurement of gastric residual volume in a hospital setting

Background

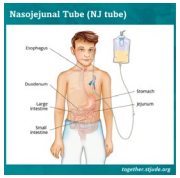

Figure 1. Feeding tube placement in relation to body anatomy

- Feeding tubes inserted into a stomach through the nose supplying nutrition when one has trouble eating
- Gastric residual volume - volume of fluid remaining in the during nutritional feeding
- Three current methods but not convenient or accurate
- Purpose: create a method easy and convenient enough to be performed in hospital setting to provide accurate measurement of remaining food content in the stomach (gastric residual volume).

Methods

Figure 2. Flask for stomach and syringe for Dye insertion

- The technical basis behind the project is the determination of the dilution of a known aliquot of dye injected into the stomach. By finding the concentration of the dye in the stomach, the healthcare providers will be able to fill in the remaining details and find the original volume of the stomach from the equations previously stated in the George Dilution Dye method.

Design

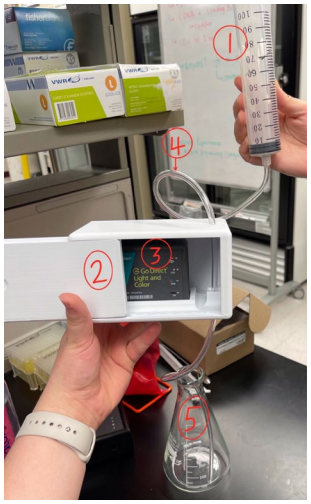

Figure 3. Model of device with light sensor and syringe

Figure 4. Model of device with light sensor and cuvette placement

- First, the stomach is simulated using a beaker (fig 3,5) and a simulated stomach acid solution, in which gastric contents are replicated.. An equal mixture of the feeding medium and the selected dye are inserted via a silicon tube into the stomach model.
- A device was created (fig 4) that consists of a 3D printed nylon PA-12 opaque box and a light sensor.
- Once we ensure that the feeding medium/dye mixture has mixed thoroughly throughout the stomach, we use the syringe to pull a sample from the stomach (fig 3,1). The light sensor shines a light through the tube which is reflected back into the RGB sensor to provide a transmittance value (fig 4).
- From that value and our sample calculations, we then derive first, an absorbance value, and secondly the volume remaining in the stomach.
- The dye used is FD&C Red No. 4 ("Allura Red"). The color of the dye is dark red, it has a max wavelength of 504 nm. Dye was chosen due to good stability to pH changes from ph 3 to 8 and excellent solubility in water.

Results

Table 1: Concentration is determined based on the dilution of the nutren sample

Dilution Factor	Concentration	Transmittance	Absorbance
1	0.0134	301	This is "I" initial
1/128	0.00015	234	0.109
1/256	0.0000525	239	0.100
1/512	0.0000262	243	0.093
1/1024	0.0000131	251	0.079
1/2048	0.00000656	266	0.054
1/4096	0.00000328	282	0.028

Derived equation:

$$1.11x[20/(20+V)]=A$$

A=Absorbance
V= Residual Gastric volume

- As concentration increases, so does absorbance, so a directly proportional relationship exists.
- Concentration is determined based on the dilution factor of the nutren sample.

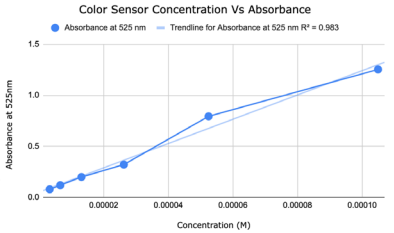

Figure 6. Correlation between Absorbance and Concentration

Conclusion

This simulated stomach setup allows us to obtain accurate measurement of the gastric residual volume by determination of the dilution of a known aliquot of dye injected into the stomach. By finding the concentration of the dye in the stomach, healthcare providers will be able to fill in remaining details and find the original volume of the stomach using this model. This method is minimally invasive due to use of the existing gastric tube only.