The below is from: http://arbl.cvmbs.colostate.edu/hbooks/pathphys/digestion/stomach/emptying.html

Control of Gastric Emptying

The rate of gastric emptying is strongly influenced by both volume and composition of gastric contents, which makes considerable sense. Consider three examples of something you might ingest and try to anticipate which rate of gastric emptying would be most appropriate:

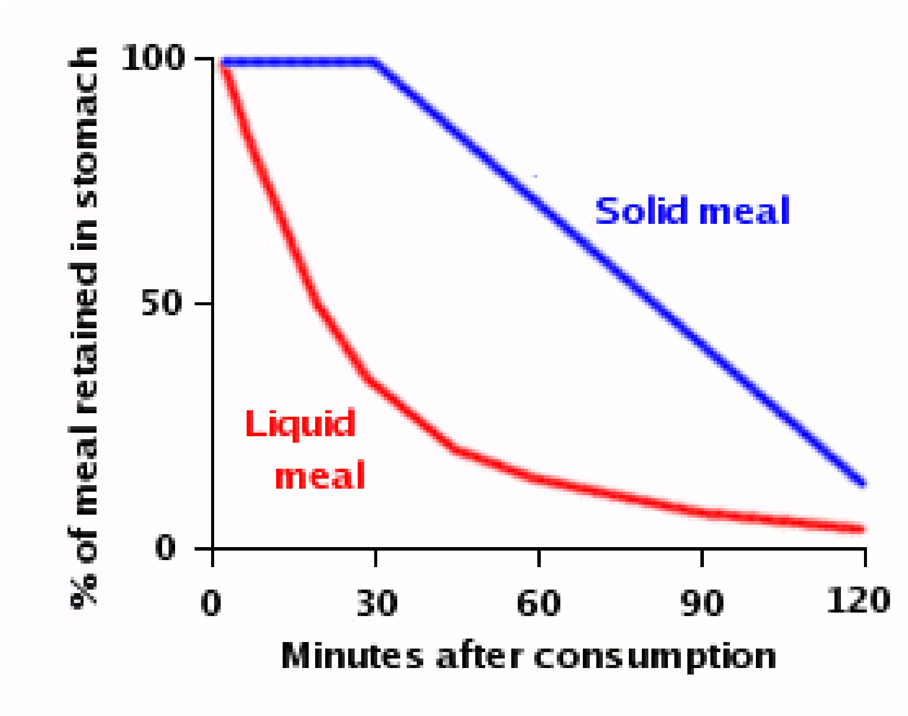
> **A large glass of water**: The stomach becomes distended, but there are no solids to grind and liquefy, and after the water reaches the small intestine, no further processing is required before absorption - the rate of gastric emptying should be very fast.
>
> **A double cheeseburger with fries** (or a mouse if you're a cat): The stomach is distended and its contents must be liquefied; you would also want the meal to be retained in the stomach long enough for pepsin and acid to get a good shot at digesting the protein. Additionally, the resulting chyme should be allowed to empty in the small intestine slowly so as to not overload that organ, particularly with regard to digestion of fat - the rate of gastric emptying should be slow.
>
> **A single chicken nugget** (or a grasshopper if you're a cat): The stomach will not be distended after this kind of a "meal" and in the absense of distension, there is relatively little stimulus for gastric motility - the rate of gastric emptying should be slow.

After consuming a typical solid meal, there is a lag time of 20 to 30 minutes in which there is minimal gastric emptying. This is followed by a phase in which the rate of emptying is roughly linear. In contrast, liquids are generally transported out of the stomach at an exponential rate.

For liquids, the principal determinant of rate of gastric emptying is volume and, secondarily, composition. If the liquid is low in nutrients (e.g. water), there is an exponential relationship between volume and rate of emptying - large volumes empty at an exponentially faster rate than small volumes.

However, if the fluid is hypertonic or acidic or rich in nutrients such as fat or certain amino acids, the rate of gastric emptying will be considerably slower and non-exponential. Indeed, the rate of gastric emptying of any meal can be predicted rather accurately by knowing its nutrient density. Nutrient density is sensed predominantly in the small intestine by osmoreceptors and chemoreceptors, and relayed to the stomach as inhibitory neural and hormonal messages that delay emptying by altering the patterns of gastric motility. The presence of fat in the small intestine is the most potent inhibitor of gastric emptying, resulting in relaxation of the proximal stomach and diminished contractions of the distal, "gastric grinder" - when the fat has been absorbed, the inhibitory stimulus is removed and productive gastric motility resumes.

Understanding the basic principles of gastric emptying facilitates management of gastric motility disorders, which are relatively common in both man and animals.



Gastrointestinal Transit: How Long Does It Take?

How long does food stay in my stomach? How long is it before a meal reaches the large intestine? *The answer to such commonly-asked questions is not necessarily simple.*

First, there is considerable normal variability among healthy people and animals in transit times through different sections of the gatrointestinal tract. Second, the time required for material to move through the digestive tube is significantly affected by the composition of the meal. Finally, transit time is influenced by such factors as psychological stress and even gender and reproductive status.

Several techniques have been used to measure transit times in humans and animals. Not surprisingly, differing estimates have been reported depending on the technique used and the population of subjects being evaluated. Some of the techniques used include:

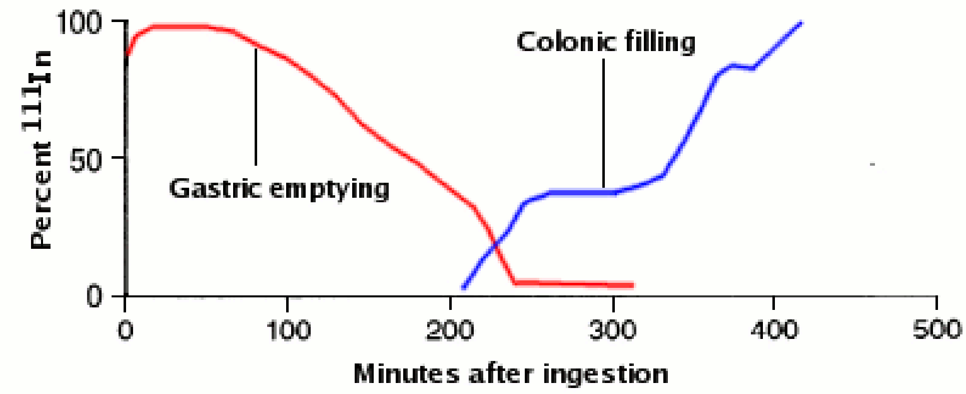
- *Radiography following a barium-labelled meal.* Sequential radiographs can be used to determine when the front of the barium label reaches different regions of the digestive tube. Such meals are not very physiologic and the technique exposes the patient to repeated exposure to radiation.
- *Breath hydrogen analysis.* A number of carbohydrates are very poorly digested or absorbed in the small intestine, but readily fermented by bacteria when they reach the large intestine. Fermentation liberates hydrogen gas, which diffuses into blood and is exhaled in breath, where it can be readily measured. Thus, after consumption of a meal containing a non-absorbable carbohydrate (lactulose or, more commonly, baked beans), there is a large increase in exhaled hydrogen when the carbohydrate reaches the large intestine. This provides an estimate of pre-colonic (stomach plus small intestine) transit time.
- *Scintigraphic analyses.* Meals containing pellets or colloids labelled with a small amount of radionuclide (^{99m}Technetium, ^{113m}Indium, etc.) are consumed, and the position of the radioactive label is sequentially monitored using a gamma camera.

Studies of gastrointestinal transit have clearly demonstrated two related phenomena important to understanding this process:

1. Substances do not move uniformly through the digestive system.
2. Materials do not leave segments of the digestive tube in the same order as they arrive.

In other words, a meal is typically a mixture of chemically and physically diverse materials, and some substances in this mixture show accelerated transit while others are retarded in their flow downstream.

An example of how ingested substances spread out in the digestive tube rather than travel synchronously is shown in the figure below. These data were obtained from a human volunteer that ingested a meal containing ^{111}Indium-labeled pellets, then measuring the location of the radioactive signal over time by scintigraphy. It is clear that parts of the meal are entering the colon at the same time that other parts are still in the stomach.



(Adapted from Camilleri, et al. Am J Physiol Gastrointest Liver Physiol 257:284, 1989.)

The discussion above should help to explain why it is difficult to state with any precision how long ingesta remains in the stomach, small intestine and large intestine. Nonetheless, there have been many studies on GI transit, and the table below presents rough estimates for transit times in healthy humans following ingestion of a standard meal (i.e. solid, mixed foods).

50% of stomach contents emptied	2.5 to 3 hours
Total emptying of the stomach	4 to 5 hours
50% emptying of the small intestine	2.5 to 3 hours
Transit through the colon	30 to 40 hours

Remember that these are estimates of average transit times, and there is a great deal of variability among individuals and within the same person at different times and after different meals.

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The below is from:
https://www.auntminnie.com/index.aspx?sec=ser&sub=def&pag=dis&ItemID=54757

Liquid glucose meal

A significant body of research has been done with gastric emptying of a glucose meal. The glucose meal has been shown to have high reproducibility in the same subject on repeat testing. The particular glucose meal used in our experiments is an 11% glucose solution, containing 50 grams of glucose in 450 mls of water. This has an osmolality of 662 mmol, a kcal content of 200 kcal and lemon-lime flavor similar to the 7-Up soda drink.

Advantages of the Glucose Meal

- Calorie content highly reproducible with every administration, unlike to the caloric variation with eggs and toast or even milk and cereal.
- Lemon lime flavor which is well tolerated by virtually all subjects.
- No problems with lactose intolerance or egg allergy.
- The osmolarity of the glucose solution is similar to commonly consumed soda beverages.
- The glucose solution is well-defined and can be standardized on an international basis.
- Normal values already exist for both males and females which are corrected based on body weight. (See normal values listed at the end of this section).
- Average gastric half-emptying time clinical reasonable. (60-80 minutes)
- Since this is not a solid meal, there is no variation in gastric emptying due to variable amounts of chewing of the meal, between subjects or the same subject at different times.
- Labeling stability is not a issue because the 99mTc-SC particles are evenly distributed throughout the liquid solution.
- Solution distributes more evenly, making performance of geometric mean less critical for clinical work (but also still recommended for research studies)

Disadvantages of the Glucose Meal

- As yet, there are no definite comparisons to other gastric emptying meals with regard to pathologic conditions, although comparative research is currently underway.
- Since this is not a solid meal, it does not test the antrum's ability to grind food into small particles. The importance of this for routine gastric emptying pathologies has not been established.

Normal Values for the Liquid Glucose Meal

The following normal values are for a 50 gram glucose meal (50 grams of glucose in 450 ml of water, as described above). Mixed group of49 subjects, 22 male and 27 female.

Percent of glucose meal remaining in the stomach		
Time (min)	% remaining	Std Dev
0	100	
15	84.3	5.2
30	70.8	5.1
45	58.7	5.2
60	47.9	5.2
75	39.0	4.5
90	30.7	3.9
105	24.6	3.2
120	19.9	2.2
T1/2	62.7	5.2