Measurements of maximal acid output

DURATION AND TIMING OF PEAK ACID OUTPUT

After a single subcutaneous or intramuscular injection of an acid stimulant, acid output rises from a basal level to its highest rate—the peak—and then declines to basal levels again. It is possible to express acid output as that collected during the total period of stimulation, such as 1 hour after histamine, gastrin, tetragastrin and pentagastrin, 1.5–2 hours after histalog, and about 2–4 hours after insulin. Alternatively, acid output can be expressed as the collection made during the peak period of secretion. However, the principle of the variable timing of peak acid output has only recently been generally accepted.

In 1923 Lim, Matheson and Schlapp found that the secretory response to injected histamine appeared within 15 minutes and lasted for 35–70 minutes (mean 58 minutes). Another of the early reports on histamine in man claimed that the maximal output occurred 30–60 minutes after the injection, but in 1925 Gompertz and Vorhaus, using 5–minute collections, showed that while this was the most common period of maximal output (66 per cent of an unstated number of tests), this maximal output might occur 0–30 minutes (11 per cent) or 60–90 minutes (22 per cent) after the injection. In 1926 Bloomfield and Keefer used 10-minute samples, and in composite studies on 16 patients Bloomfield and Polland later found that the maximal secretory output most commonly occurred in the 20–30 minute period. In 1934 Maclagan criticised this maximal 10-minute secretory volume as too short and ‘too liable to be affected by difficulty in emptying the stomach’, while he considered Comfort and Osterberg’s 0–30 minute collection was often too brief to include the peak. Lander and Maclagan therefore chose the period 10–50 minutes as covering the maximal volume and acidity in all their 100 normal students, and they multiplied the output in this period by 1.5 to convert it to output per hour.

Moreover, the timing of this peak secretion may vary not only from subject to subject, but also from day to day in the same subject, presumably because of the varying rates of diffusion of histamine from the site of the injection. However, this point was commonly ignored in subsequent years and Kay, finding the maximal output to occur within the mid-30 minutes of secretion.
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(that is, during the period 15–45 minutes after histamine) in each of eight patients with duodenal ulcer, chose this 15–45-minute period as the best measure of maximal acid secretion. Others have used 0–45 minutes. Lim approached the problem differently. He preferred to consider the response to histamine as the output after histamine minus the basal output, and similarly Hunt subtracted the output in the basal 45 minutes from that in the post-histamine 45 minutes.

MAXIMUM ACID OUTPUT

Although Kay used the acid output in the period 15–45 minutes after histamine as his measure of maximal acid output, the term maximum acid output was used by others for the acid output in the whole hour, 0–60 minutes, after histamine or pentagastrin. Writers on gastric secretion also use the terms maximum or maximal acid output for the highest observed response to a single parenteral dose. The term is, however, misleading because maximal acid output does not imply or represent the highest observable secretory output of which the stomach is capable: intravenous infusions of histamine may elicit higher acid responses, and the newer H$_2$-agonist histamine analogues even more. Nor does 'maximal acid output' mean what it might alternatively be thought to imply, namely the utmost capacity of a human stomach to secrete acid. It is possible to derive from dose–response curves a calculated maximal secretory capacity. By definition 100 per cent of this calculated maximum can never be obtained experimentally, and the various available gastric stimuli probably achieve 75–90 per cent of this calculated maximum, depending on the route. A theoretical calculated maximum offers no clinical advantage, and the observed maximal secretion is to be preferred.

It is, of course, possible to use intravenous infusions of histamine or pentagastrin clinically to obtain the highest observable response, but these are more complicated and less convenient than single injections. The problem remains whether to use the whole hour output after a stimulant, or to utilise the concept of peak acid output.

PEAK ACID OUTPUT

Marks, Komarov and Shay showed that in dogs with fistulas of the whole stomach, the highest output in the two consecutive highest periods of acid secretion following a subcutaneous injection of histamine was almost identical with the highest plateau acid output after intravenous injections of histamine in the same dogs, and both were identically correlated with parietal cell mass. The same concept of approximating to the plateau acid output after an intravenous injection, and lessening collection errors, by taking the two consecutive highest collection periods rather than the single maximal period,