CIMETIDINE IN THE PREVENTION OF THE PULMONARY
ACID ASPIRATION (MENDELSON'S) SYNDROME

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SUMMARY
Cimetidine 200 mg was given i.v. 1 h before induction of anaesthesia to 20 patients about to undergo emergency surgery. There was an increase in pH of gastric aspirate in all patients (P < 0.001) and in 80% pH was greater than 2.5 units at the time of induction of anaesthesia. The pH of gastric aspirate continued to increase after induction of anaesthesia and was greater than 4 units in all patients at the time of tracheal extubation and in the early recovery period.

Pulmonary acid aspiration (Mendelson's) syndrome is responsible for a considerable proportion of the deaths associated with anaesthesia (Morton and Wylie, 1951; Edwards et al., 1956; Clifton and Hotten, 1963; Dinnick, 1964; Report, 1970–72) and has been recognized as a major hazard in the practice of emergency anaesthesia (Hall, 1940; Mendelson, 1946; Morton and Wylie, 1951). Experimental work in animals suggests that pulmonary damage is greatest when fluids with pH less than 2.5 units are aspirated (Teabeaut, 1952; Taylor and Pryse-Davies, 1966). The risk of the pulmonary acid aspiration syndrome may be reduced therefore by increasing the pH of gastric contents to more than 2.5 before induction of anaesthesia.

Cimetidine, a specific histamine H₂ receptor antagonist, reduces gastric acid secretion (Burland et al., 1975), but has little effect on the tone of the lower oesophageal sphincter (Bailey et al., 1976; Carter et al., 1977) or the rate of gastric emptying (Heading et al., 1977). This study was designed to investigate the effectiveness of cimetidine in reducing the acidity of stomach contents in patients about to undergo emergency surgery.

PATIENTS AND METHODS
Twenty patients (17 male, three female; mean age 44 yr, range 16–73 yr) were investigated. All were undergoing emergency surgery (table I) and all could be expected to have a “full stomach” according to the criteria suggested by Morton and Wylie (1951). No premedication was given (although three patients received as much as 100 mg of pethidine for analgesia).

One hour before surgery a 16-f.g. nasogastric tube was passed and up to 10 ml of stomach content aspirated. Cimetidine 200 mg was then given i.v. Further aliquots of 5–10 ml of gastric aspirate were removed at 15-min intervals. At the fifth aspiration, immediately before induction, the stomach was emptied as completely as possible. After induction of anaesthesia aspiration was repeated every 15 min until approximately 1 h after completion of surgery.

After pre-oxygenation of the patient, anaesthesia was induced with a predetermined dose of thiopentone followed immediately by suxamethonium 100 mg to facilitate orotracheal intubation. Maintenance of anaesthesia was determined by the nature of the surgery being performed and the condition of each patient, and was not standardized.

pH of the samples was measured within 12 h using a Radiometer TTT2 pH electrode and meter. The equipment was calibrated against standard buffers of pH 4, 7 and 9 units.

The results were analysed statistically using a paired t test.

The study was approved by the hospital ethics committees and all patients gave informed consent.

RESULTS
pH of gastric aspirate before administration of cimetidine before induction of anaesthesia is shown in table I. In 13 patients pH was less than 2.5 before receiving cimetidine. One hour after cimetidine only four patients still had a gastric aspirate pH of less than 2.5, although in these four pH was increasing.
**Table I. Details of patients and the change in intragastric pH before induction of anaesthesia.**

*Received up to 100 mg of pethidine*

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Age (yr)</th>
<th>Sex</th>
<th>Surgical condition</th>
<th>pH (units) before Cimetidine</th>
<th>pH (units) before Induction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>25</td>
<td>M</td>
<td>Small bowel obstruction</td>
<td>1.2</td>
<td>7.7</td>
</tr>
<tr>
<td>2*</td>
<td>24</td>
<td>M</td>
<td>Torsion of testis</td>
<td>1.8</td>
<td>2.9</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>M</td>
<td>Stab wound</td>
<td>5.1</td>
<td>6.9</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>M</td>
<td>Perforated appendix</td>
<td>2.4</td>
<td>3.4</td>
</tr>
<tr>
<td>5</td>
<td>65</td>
<td>F</td>
<td>Small bowel obstruction</td>
<td>5.3</td>
<td>6.8</td>
</tr>
<tr>
<td>6</td>
<td>61</td>
<td>M</td>
<td>Compound Pott's fracture</td>
<td>1.9</td>
<td>3.8</td>
</tr>
<tr>
<td>7</td>
<td>61</td>
<td>M</td>
<td>Perforated gastric ulcer</td>
<td>1.5</td>
<td>2.3</td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>F</td>
<td>Chylous ascites</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
<td>9</td>
<td>73</td>
<td>F</td>
<td>Repair of bowel fistula</td>
<td>5.7</td>
<td>5.9</td>
</tr>
<tr>
<td>10</td>
<td>70</td>
<td>M</td>
<td>Strangulated inguinal hernia</td>
<td>3.2</td>
<td>6.8</td>
</tr>
<tr>
<td>11</td>
<td>23</td>
<td>M</td>
<td>Multiple fractures</td>
<td>1.7</td>
<td>3.1</td>
</tr>
<tr>
<td>12</td>
<td>58</td>
<td>M</td>
<td>Multiple fractures</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>13</td>
<td>47</td>
<td>M</td>
<td>Abdominal stab wound</td>
<td>1.8</td>
<td>2.3</td>
</tr>
<tr>
<td>14</td>
<td>25</td>
<td>M</td>
<td>Perforated appendix</td>
<td>1.7</td>
<td>2.8</td>
</tr>
<tr>
<td>15*</td>
<td>55</td>
<td>M</td>
<td>Small bowel obstruction</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>16</td>
<td>55</td>
<td>M</td>
<td>Emergency tracheotomy</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>17</td>
<td>65</td>
<td>M</td>
<td>Bleeding duodenal ulcer</td>
<td>4.9</td>
<td>5.9</td>
</tr>
<tr>
<td>18</td>
<td>19</td>
<td>M</td>
<td>Abdominal stab wound</td>
<td>2.0</td>
<td>5.1</td>
</tr>
<tr>
<td>19</td>
<td>21</td>
<td>M</td>
<td>Abdominal stab wound</td>
<td>2.0</td>
<td>2.8</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>M</td>
<td>Stab wound</td>
<td>5.9</td>
<td>6.5</td>
</tr>
</tbody>
</table>

The change in pH for each subject is shown in figure 1; the difference is statistically significant ($P < 0.001$). The number of patients with an aspirate pH less than 2.5 decreased with time after cimetidine (fig. 2). During surgery the pH increased to greater than 4 in all patients, and greater than 5 in all but one, and remained greater than 4 in all patients at the time of tracheal extubation.

No patient developed a pulmonary complication; there were no deaths or even side-effects which could be attributed to cimetidine.

**Fig. 2.** Number of patients with a gastric aspirate pH of less than 2.5 at different times after cimetidine.

**Discussion**

It is generally thought that the critical pH for pulmonary complications following aspiration of stomach contents is 2.5 (Roberts and Shirley, 1974; Editorial, 1977) although there has been a case report of pulmonary symptoms developing after aspiration of material with a greater pH (Taylor, 1975).

Oral antacids are used widely for increasing intragastric pH before emergency surgery and a number of studies have assessed the effectiveness of antacid therapy. These have shown 42–55% (Taylor and Pryse-Davies, 1966; Roberts and Shirley, 1974) of obstetric patients and 46–63% (Hester and Heath,
of elective non-obstetric patients to have a gastric aspirate pH of less than 2.5 without treatment.

In the present study 13 patients (65%) had a pH of less than 2.5 before treatment and this decreased to four (20%) at induction of anaesthesia, 1 h after cimetidine had been given. In these four patients no common factor was found, such as diagnosis, volume of aspirate at induction, or time since last meal, to account for the failure to respond rapidly to cimetidine. In obstetric patients given magnesium trisilicate the proportion of patients with a pH remaining less than 2.5 has varied widely, being reported variously as none (Taylor and Pryse-Davies, 1966), 8.5% (Peskett, 1973), 16% (Roberts and Shirley, 1974) and 20% (White, Clarke and Stanley-Jones, 1976). Cimetidine therefore reduced the proportion of patients with a pH less than 2.5 to a number similar to that achieved by some investigators with oral antacids, even though a greater proportion of patients than is usual in obstetrics had an initial pH of less than 2.5. In elective non-obstetric patients Hutchinson and Newson (1975) found that the proportion with a gastric aspirate pH less than 2.5 was 53% in untreated controls and 19% in those receiving magnesium trisilicate 30 min or more before anaesthesia. However, magnesium trisilicate given less than 30 min before anaesthesia was considerably more effective.

An important disadvantage of cimetidine for use before emergency surgery is that no worthwhile effect was seen until 45 min after injection. However, the delays in organizing emergency surgery, such as documentation, completion of investigations, cross-matching of blood and preparation of the surgical instruments, are such that in none of the patients was anaesthesia induced before 1 h after the injection of cimetidine, and in practice the cimetidine had to be withheld until 1 h before the time arranged for surgery. The continued increase in pH observed after 1 h suggests that cimetidine given as soon as possible would be even more effective. This is supported by the results of Husemeyer, Davenport and Rajasekaran (1978) who found in elective gynaecological surgery that oral cimetidine 400 mg 2.5–9 h before induction of anaesthesia reduced, from 70% to 90%, the proportion of patients with a gastric aspirate pH of less than 2.5 after induction of anaesthesia. The prolonged action of cimetidine means that at the time of extubation and in the early recovery period, when patients are again at risk, the pH of gastric contents remains high.

ACKNOWLEDGEMENTS

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REFERENCES


LA CIMETIDINE POUR LA PREVENTION DU SYNDROME DE MENDELSON—ASPIRATION D'ACIDE PULMONAIRE

RESUME
On a administré 200 mg de cimétidine par voie intraveineuse, 1 h avant l'induction de l'anesthésie, à 20 malades sur le point de subir une intervention chirurgicale d'urgence. Il y a eu une augmentation du pH de la déglutition gastrique chez tous les malades (P<0,001) et dans 80% des cas le pH a été supérieur à 2,5 unités au moment de l'induction de l'anesthésie. Le pH de la déglutition gastrique a continué à augmenter après l'induction de l'anesthésie et était supérieur à 4 unités chez tous les malades au moment de l'extubation trachéale et au début de la période de récupération.

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CIMETIDIN ZUR VORBEUGUNG DES PULMONAREN SÄUREANSAUGUNGSSYNDROMS (MENDELSON)

ZUSAMMENFASSUNG
Cimetidin (200 mg) wurde 20 Patienten 1 Stunde vor Narkose für Notoperationen verabreicht. Es gab einen Anstieg von pH bei der gastrischen Ansaugung aller Patienten (P<0,001), und bei 80% war pH größer als 2,5 Einheiten bei Narkosebeginn. Das pH der gastrischen Ansaugung stieg nach Narkosebeginn weiter und war bei allen Patienten größer als 4 Einheiten zum Zeitpunkt der Entfernung des Trachealrohres und der ersten Erholungszeit.

CIMETIDINA EN PREVENCIÓN DEL SÍNDROME (DE MENDELSON) DE ASPIRACION PULMONAR ACIDA

SUMARIO
Se administró a 20 pacientes a punto de someterse a operaciones de emergencia 200 mg de cimetidina i.v. 1 h antes de la inducción de la anestesia. Se observó un aumento del pH del aspirado gástrico de todos los pacientes (P<0,001) y en el 80% de ellos, el pH era mayor de 2,5 unidades al momento de la inducción de la anestesia. El pH del aspirado gástrico siguió aumentando después de la inducción de la anestesia y era mayor de 4 unidades en todos los pacientes al momento de la extubación traqueal y al principio del periodo de recuperación.