Concurrent Chemo - Radiotherapy in Carcinoma of Stomach

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• Despite curative resection a majority of patients will develop recurrence

• Trials had failed to demonstrate an improvement in survival with adjuvant therapy compared with surgery alone

• Questions remain regarding the optimal treatment regimen and clinical trials are ongoing
• Surgery is the mainstay of treatment

• Approximately 50% of patients are not candidates for resection due to the presence of unresectable, locally advanced disease or metastases

• Even among patients undergoing gastrectomy with curative intent, 5-year survival rates range from 15% to 30% due to locoregional relapse and distant metastases

• Due to the heterogeneity in therapeutic regimens and methodologic quality of trials done, surgery has remained the standard of care.
Patterns of Failure following potentially curative surgery  
Cumulative Incidence of failure (%)  

<table>
<thead>
<tr>
<th>Local Failure by TNM stage</th>
<th>Clinical</th>
<th>Reoperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1N0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>T1-2N0</td>
<td>19</td>
<td>-</td>
</tr>
<tr>
<td>T3N0</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>T4N0</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>T1-2N1-2</td>
<td>24</td>
<td>-</td>
</tr>
<tr>
<td>T3N1-2</td>
<td>36</td>
<td>-</td>
</tr>
<tr>
<td>T4N1-2</td>
<td>56</td>
<td>-</td>
</tr>
</tbody>
</table>

Patterns of Failure following potentially curative surgery
Cumulative Incidence of failure (%)

<table>
<thead>
<tr>
<th>Failure Site</th>
<th>Clinical</th>
<th>Reoperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Local/Regional</td>
<td>38</td>
<td>67</td>
</tr>
<tr>
<td>Gastric Bed</td>
<td>21</td>
<td>54</td>
</tr>
<tr>
<td>Abdominal Scar</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Anastomosis</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Nodes</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Peritoneal Seedling Local</td>
<td>23</td>
<td>41</td>
</tr>
<tr>
<td>Diffuse</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Distant</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>
Combination of RT and CT

• Neoadjuvant/Preoperative CTRT
• Neoadjuvant/Perioperative CT
• Adjuvant/Postoperative CTRT
• Adjuvant CT
Preoperative CTRT

- Not a standard of care
- Some centres use it in T2 or node positive adenocarcinoma involving both the GE junction and stomach
- Pre treatment laparoscopy is mandatory to exclude patients with radiographically undetected peritoneal or liver metastasis
- Pathologic CR 25%
- 80-90% chance of complete resection with negative margins
### Preoperative CTRT (RTOG 9904 trial)

<table>
<thead>
<tr>
<th>Number of Patients</th>
<th>43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>T2-T3  N1-N2 Lap -ve</td>
</tr>
<tr>
<td>Treatment</td>
<td>5FU/leucovorin/cisplatin x 2  45 Gy RT + 5FU/paclitaxel Surgery</td>
</tr>
<tr>
<td>Surgery</td>
<td>36 underwent surgery (7 disease progression). 50% D2 resection. pCR 26%</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Grade 4 acute toxicity 21%</td>
</tr>
<tr>
<td>Median Survival</td>
<td>23 months</td>
</tr>
</tbody>
</table>
Rationale of Adjuvant Therapy

• Patterns of failure following potentially curative surgery

• Failure assessed by clinical methods, re-operation methods or both

• Clinical methods use physical exam, and radiological studies and re-operation methods use second look surgery every 6 months (more accurate but not commonly used)

• Incidence of local failure increases with increasing penetration of the wall and positive lymph nodes

• Local failure is significant even with R0 resections
INT 0116: Treatment Schema


Resected gastric cancer
Stage IB–IV (MO)

Randomize

n=275

→ Observation

n=281

→ 5-FU/LV

→ Radiation 4,500 cGy

5-FU/LV × 2
### INT 0116: 5 year survival by T and N status

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CTRT (%)</th>
<th>Surgery Only (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nodal Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N0</td>
<td>60</td>
<td>44</td>
</tr>
<tr>
<td>N1-N3</td>
<td>50</td>
<td>37</td>
</tr>
<tr>
<td>N &gt; 4</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td><strong>Stage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1-T2</td>
<td>56</td>
<td>38</td>
</tr>
<tr>
<td>T3</td>
<td>38</td>
<td>20</td>
</tr>
</tbody>
</table>

![Graph showing survival rates over time](chart.png)
Overall survival (OS) and relapse-free survival (RFS) data demonstrate continued strong benefit from postoperative radiochemotherapy.

The hazard ratio (HR) for OS is 1.32 (95% CI, 1.10 to 1.60; P = .0046). The HR for RFS is 1.51 (95% CI, 1.25 to 1.83; P < .001).

Adjuvant radiochemotherapy produced substantial reduction in both overall relapse and locoregional relapse. There were significantly fewer local and regional recurrences in the chemoradiotherapy group but no difference in the rates of distant recurrences. Can we conclude from these findings that the underlying survival benefit of chemoradiotherapy is principally a consequence of preventing locoregional recurrences?

Second malignancies were observed in 21 patients with radiotherapy versus eight with observation (P = .21).

Subset analyses show robust treatment benefit in most subsets, with the exception of patients with diffuse histology who exhibited minimal nonsignificant treatment effect.

Conclusion

- Adjuvant radiochemotherapy produced substantial reduction in both overall relapse and locoregional relapse.

- Second malignancies were observed in 21 patients with radiotherapy versus eight with observation (P = .21).

- Subset analyses show robust treatment benefit in most subsets, with the exception of patients with diffuse histology who exhibited minimal nonsignificant treatment effect.

- Toxicities, including second malignancies, appear acceptable, given the magnitude of RFS and OS improvement.

- LRF reduction may account for the majority of overall relapse reduction.

- Adjuvant radiochemotherapy remains a rational standard therapy for curatively resected gastric cancer with primaries T3 or greater and/or positive nodes.
CALGB 80101

N= 540

Primary Outcome: OS

Population: Resected gastric or GE junction adenocarcinoma, T3/4 or node +

5-FU/LV Arm

5-FU/LV X1 → 5-FU IVCI RT → 5-FU/LV X2

ECF Arm

ECF X1 → 5-FU IVCI RT → ECF X2

Accrual Over
## CALGB: Results

<table>
<thead>
<tr>
<th></th>
<th>5-FU/LV (n = 280)</th>
<th>ECF (n = 266)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Median DFS</strong></td>
<td>30.1 mos</td>
<td>28.2 mos</td>
<td>-</td>
</tr>
<tr>
<td><strong>5Y-DFS</strong></td>
<td>35%</td>
<td>38%</td>
<td>p = 0.99</td>
</tr>
<tr>
<td><strong>Median OS</strong></td>
<td>36.6 mos</td>
<td>37.8 mos</td>
<td>-</td>
</tr>
<tr>
<td><strong>5Y-OS</strong></td>
<td>41%</td>
<td>44%</td>
<td>p = 0.80</td>
</tr>
</tbody>
</table>
### CALGB: Toxicity

<table>
<thead>
<tr>
<th></th>
<th>5FU/LV Grade 3/4</th>
<th>ECF Grade 3/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>15%</td>
<td>7%</td>
</tr>
<tr>
<td>Mucositis</td>
<td>15%</td>
<td>7%</td>
</tr>
<tr>
<td>Dehydration</td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>Grade 4 Neutropenia</td>
<td>33%</td>
<td>19%</td>
</tr>
</tbody>
</table>
Following curative resection of gastric or GE junction adenocarcinoma, adjuvant treatment using ECF and chemoradiation does not improve survival when compared to 5-FU/LV and chemoradiation.

- ECF and chemoradiation was associated with less severe diarrhea, mucositis and neutropenia than 5-FU/LV and chemoradiation.
- ECF and chemoradiation can be considered as an option for the adjuvant treatment of resected gastric cancer based on equivalent efficacy and reduced toxicity compared to the current standard of 5-FU/LV and chemoradiation.
- Multidisciplinary assessment of patients with resectable gastric cancer should determine whether best treatment option is perioperative ECF or surgery followed by ECF and chemoradiation.
To investigate the role of postoperative chemoradiotherapy therapy in patients with curatively resected gastric cancer with D2 lymph node dissection. This trial was designed to compare postoperative treatment with capecitabine plus cisplatin (XP) versus XP plus radiotherapy with capecitabine (XP/XRT/XP).

XP ARM: Chemotherapy Arm: Six cycles of XP (capecitabine 1,000 mg/m2 BD on days 1 to 14 and cisplatin 60 mg/m2 on day 1, repeated every 3 weeks) chemotherapy

XP/XRT/XP ARM: two cycles of XP (1000 mg/m2 BD Day 1-14): Followed by 45-Gy (1.8 Gy/#) XRT (capecitabine 1,650 mg/m2 per day for 5 weeks) and two cycles of XP (1,000 mg/m2 BD on days 1 to 14 and cisplatin 60 mg/m2 on day 1, repeated every 3 weeks)
ARTIST Trial

Enrolled (N = 458)

Randomly assigned (n = 228)
  XP arm (n = 226)
    Refused before treatment (n = 2)
  Discontinued (n = 54)
    Refused treatment (n = 20)
    Documented recurrence (n = 4)
    Adverse events (n = 20)
    Others (n = 10)

Completed planned treatment (n = 172)
  Final analysis (n = 228)

Randomly assigned (n = 230)
  XP/XRT/XP arm (n = 227)
    Refused before treatment (n = 3)
  Discontinued during XP#1-2 (n = 24)
    Refused treatment (n = 17)
    Adverse events (n = 3)
    Others (n = 4)
  Discontinued during XRT (n = 3)
    Adverse events (n = 2)
    Refused treatment (n = 1)
  Discontinued during XP#3-4 (n = 12)
    Adverse events (n = 7)
    Disease recurrence (n = 2)
    Refused treatment (n = 2)
    Others (n = 1)

Completed planned treatment (n = 188)
  Final analysis (n = 230)
ARTIST : Results

DFS survival according to stage

XP: Capecitabine + Cisplatin
XRT: Capecitabine + RT

DFS in (A) all patients
(B) lymph node positive patients
Conclusion

- The addition of XRT to XP chemotherapy did not significantly prolong disease-free survival (DFS; \( P = .0862 \)).

- In the subgroup of patients with pathologic lymph node metastasis, patients in XP/XRT/XP arm experienced superior DFS when compared with those who received XP alone (\( P = .0365 \)).

- The addition of XRT to XP chemotherapy did not significantly reduce recurrence after curative resection and D2 lymph node dissection in gastric cancer.

- A subsequent trial (ARTIST-II) in patients with lymph node-positive gastric cancer is planned.

MAGIC Trial

1994–2002

Resectable gastric, GE junction and lower esophagus cancer, Stage II–IV (MO)

n=250

ECF × 3 → Surgery → ECF × 3

n=253

Surgery
Results

- Five years after the initial publication of INT-0116, the British MAGIC (MRC Adjuvant Gastric Infusional Chemotherapy Trial) trial demonstrated the superiority of epirubicin, cisplatin, and fluorouracil (ECF) administered before and after surgical resection when compared with surgery alone.

- Despite the omission of radiotherapy, perioperative ECF conferred a statistically and clinically significant reduction in death and cancer recurrence, establishing perioperative chemotherapy, without radiation therapy, as an alternative, reasonable standard in the adjuvant treatment of gastric cancer.
S-1 is a novel oral fluorouracil anticancer product that combines 3 pharmacological agents: tegafur which is a pro-drug of 5 fluoro-uracil; gimeracil (5-chloro-2,4 dihydropyridine (CDHP)) which inhibits dihydropyrimidine dehydrogenase (DPD) enzyme activity; and oteracil (potassium oxonate (Oxo)) a gastrointestinal side effects corrector.
ACTS GC: Results

- 3 Yr Survival
  - Surgery: 70.1%
  - Adj. S-1: 80.1%

P = 0.002
CT vs CTRT

CRITICS TRIAL

- Preoperative chemotherapy
  - Epirubicine
  - Cisplatin
  - Capecitabine

- D1+ surgery

- 3 x ECC q 3 wks

- Chemoradiation

- ≥ 15 Lymph nodes
- No splenectomy
- 45 Gy/25 fx + Capecitabine bid
- Cisplatin weekly

- Stratified for:
  - Centre
  - Histological type
  - Localisation of tumour

- Tissue/blood banking

- QoL

- 2 wks
- 3-6 wks
- 4-12 wks
CLASSIC Trial

Phase 3, randomised controlled trial undertaken in 37 centres in South Korea, China, and Taiwan.
Stage II—IIIB (1035 patients (520 to receive CT and surgery, 515 surgery only)
Curative D2 gastrectomy
Randomly assigned to receive
- Adjuvant chemotherapy of eight 3-week cycles of oral capecitabine (1000 mg/m² twice daily on days 1 to 14 of each cycle) plus intravenous oxaliplatin (130 mg/m² on day 1 of each cycle) for 6 months
- Surgery only

This study reports a prespecified interim efficacy analysis, after which the trial was stopped after a recommendation by the data monitoring committee.
Median follow-up was 34·2 years
3 year disease-free survival was
- 74% (95% CI 69—79) in the chemotherapy and surgery group and 59% (53—64) in the surgery only group (hazard ratio 0·56, 95% CI 0·44—0·72; p<0·0001).
Grade 3 or 4 adverse events were reported in 279 of 496 patients (56%) in the chemotherapy and surgery group and in 30 of 478 patients (6%) in the surgery only group.
## INT 0116 vs MAGIC vs ACTS GC

<table>
<thead>
<tr>
<th></th>
<th>MAGIC</th>
<th>ACTS-GC</th>
<th>INT 0116</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Pts</td>
<td>503</td>
<td>1059</td>
<td>554</td>
</tr>
<tr>
<td>T3/T4</td>
<td>64% *</td>
<td>46%</td>
<td>68%</td>
</tr>
<tr>
<td>Node Negative</td>
<td>28% *</td>
<td>11%</td>
<td>15%</td>
</tr>
<tr>
<td>Node Positive</td>
<td>72% *</td>
<td>89%</td>
<td>85%</td>
</tr>
</tbody>
</table>

*Surgery Only Arm*
5 Year Survival Rates

<table>
<thead>
<tr>
<th>Study</th>
<th>Surgery (%)</th>
<th>CTRT/CT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INT 0116</td>
<td>28</td>
<td>43</td>
</tr>
<tr>
<td>MAGIC</td>
<td>23</td>
<td>36</td>
</tr>
<tr>
<td>ACTS-GC</td>
<td>61</td>
<td>72</td>
</tr>
</tbody>
</table>

ACTS-GC results are strikingly better both for treatment and for the surgery-only controls than the MAGIC perioperative chemotherapy results and INT0116
Radiation Therapy Planning

- Preoperative CT scans/GI series/operative findings/clips placement define the tumor bed and nodal areas

- Target Volume: Tumor bed, primary lymph nodes, and a margin of 1.5-2.0 cm

- Tumor bed includes the maximum preoperative stomach volume. In T3-T4 tumors, it

- Should include areas of local tumor extension and medial two thirds to three fourths of Left hemi diaphragm

- Half to two thirds of left kidney should be blocked. Porta hepatis and retroduodenal

- Nodes can be treated while including a small portion of right kidney

- Nodes at risk: celiac, porta hepatis, subpyloric, gastroduodenal, splenic-suprapancreatic, retropancraticodudenumal
### Radiation Therapy Planning

<table>
<thead>
<tr>
<th><strong>AP-PA Field</strong></th>
<th><strong>Lat Field (if used)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior Border</td>
<td>Superior Border/ Inferior Border</td>
</tr>
<tr>
<td>Inferior Border</td>
<td>Anterior Border</td>
</tr>
<tr>
<td>Left Border</td>
<td>Posterior Border</td>
</tr>
<tr>
<td>Right Border</td>
<td></td>
</tr>
</tbody>
</table>

#### Bottom of T8-T9
- Bottom of L3
- 2/3rd to 3/4th of left hemidiaphragm
- 3-4 cm lateral to vertebral bodies

#### Dose
- Anterior abdominal wall
- Include ½ to 2/3rd of the vertebral bodies
- 45 Gy (1.8 Gy/Fraction)

#### Dose to critical organs
- Liver
- Heart
- Kidneys
- Spinal Cord
- No > 60% of liver to receive >30 Gy
- No >30% should receive >40 Gy
- Spare as much as possible
- Limited to 45 Gy
Techniques to decrease RT Toxicity

- High Energy (>10 MV)
- Treatment 5 days a week and all fields every day
- Port films at least once a week
- Minimize hot spots and increase homogeneity in target volume
- 3D planning to generate DVH’s for liver, kidneys, and small intestine
- Ideal field arrangement (AP-PA vs multiple fields) is the one that a) delivers the most homogeneous dose distribution with in the target volume while b) limiting the dose to critical organs
- AP-PA fields are preferred as addition of lateral field increases the dose to kidneys.
- Some cases where the fundus of stomach is sufficiently anterior a lateral field can be used
• Among the principal concerns regarding INT-0116 has been the quality of surgical resections performed on the study population as majority of patients received less than a D1 lymph node dissection at surgery (<10% had D2 resection)

• No clear survival benefit from D2 lymphadenectomy

• High rate of <D1 resections in INT-0116 gave way to speculation that postoperative chemoradiotherapy simply compensated for inadequate surgery.

• Updated report of INT-0016 finds no evidence that the survival benefit associated with chemoradiotherapy differs according the extent of lymph node dissection, allaying some concerns that chemoradiotherapy only benefits those patients who undergo substandard resection

• The durable benefit associated with postoperative chemoradiotherapy in INT-0116 and the apparent trends reported in the ARTIST trial uphold postoperative chemoradiotherapy as a standard adjuvant approach
Two ongoing trials should refine our understanding

The ARTIST-II trial will include patients with lymph node–positive gastric cancer

The ongoing phase III CRITICS trial will evaluate the benefits of adding postoperative chemoradiotherapy to perioperative combination epirubicin, cisplatin, and capecitabine (ECX)

Until those trials are mature, adjuvant chemoradiotherapy remains one of the available strategies