WORLD WAR ONE:

THE EVOLUTION OF ABDOMINAL SURGERY FOR TRAUMA

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KEY POINTS, EVOLUTION, WWI ABDOMINAL SURGERY:

- BRIEF HISTORY, ABDOMINAL SURGERY THROUGH 19TH CENTURY
- MANAGEMENT, ABDOMINAL TRAUMA, TURN OF 20TH CENTURY
- INCIDENCE, ABDOMINAL INJURIES, WWI
- PIONEERS OF SURGERY FOR ABDOMINAL TRAUMA
- CONCOMITANT ADVANCES AND ABDOMINAL SURGERY
- DATA AND RESULTS
- LESSONS LEARNED FOR THE FOLLOWING CENTURY TO THE PRESENT
BRIEF HISTORY, SURGERY FOR ABDOMINAL TRAUMA: PRE-ANESTHESIA/ANTISEPSIS

- HOMERIC GREEKS
- ROMANS
- AGE OF GUNPOWDER:
  - AMBROISE PARÉ (16TH CENTURY)
- WILLIAM CULLEN (1676)
- JOHN HUNTER (18TH CENTURY)
“GUTSHOT”

- Matthew Brady:
- Battle of Sharpsburg, MD, Dunker Church—After 17 Sep, 1862
BRIEF HISTORY OF ABDOMINAL SURGERY FOR TRAUMA: PRE-WWI

POSTANESTHESIA SURGERY LANDMARKS:

SIR JOSEPH LISTER (1867): ANTISEPSIS

GOODFELLOW (1881): SURGERY for ABDOMINAL TRAUMA

BILLROTH, CZERNY, MICKULICSZ
PIONEERS OF ABDOMINAL SURGERY, LATTER HALF, 19TH CENTURY:

Sir Joseph Lister  Theodor Billroth  George E. Goodfellow
BOER WAR EXPERIENCE, ABDOMINAL TRAUMA (1899-1902)

- TOTAL of 207 ABDOMINAL WOUNDSRecorded
- 26 ATTEMPTED LAPAROTOMIES
- SURGICAL MORTALITY RATE OF 70%
- APHORISM of SIR Wm MacCORMAC
- DRY, STERILE SOIL OF BATTLEFIELDS
MILITARY CONSENSUS ON ABDOMINAL SURGERY FOR TRAUMA: 1914

- At commencement of the First World War, military medical orthodoxy called for “expectant management”
- Dictum contrary to emerging civilian surgical practice and experience
- >80% mortality with expectant management of abdominal trauma
PRINCIPLES, EXPECTANT MANAGEMENT OF ABDOMINAL TRAUMA: 1914

- Patient placed in Fowler’s position
- Patient kept warm (stove, hot water bottles)
- NPO for three days
- Morphine
- Rectal saline infusions
VERA GEDROITZ (1876-1932)

- RUSSO-JAPANESE WAR
- ADVOCATE OF SURGERY FOR PENETRATING ABD TRAUMA
- SURGERY WITHIN 3 HOURS OF INJURY
- 168 LAPAROTOMIES
- RESULTS IGNORED BY THE WEST
ESTIMATED NUMBER OF MILITARY WOUNDED IN WWI: 22,000,000

- ESTIMATED NO., ABDOMINAL INJURIES TRANSFERRED BY FIELD AMBULANCE (BEF):
  - 1.92% ALL INJURIES
  - ~ 442,000 ABD CASUALTIES

- ESTIMATED NO., ABDOMINAL INJURIES ARRIVING AT CASUALTY CLEARING STATIONS (BEF):
  - 0.72% ALL INJURIES
  - ~ 160,000 ABD CASUALTIES

IMPLICATION → 62.5% OF ABDOMINAL INJURIES DIED DURING TRANSFER TO CCS, DEFINITIVE CARE
DISTRIBUTION AND CAUSE OF PENETRATING ABDOMINAL WDS, WWI:

<table>
<thead>
<tr>
<th>ORGAN WOUNDED</th>
<th>BULLET (%)</th>
<th>SHELL/SHRAPNEL (%)</th>
<th>BAYONET (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOMACH</td>
<td>46.2 %</td>
<td>53.8%</td>
<td>0</td>
</tr>
<tr>
<td>SMALL BOWEL</td>
<td>15.5</td>
<td>16.2</td>
<td>0</td>
</tr>
<tr>
<td>LARGE BOWEL (COLON)</td>
<td>11.9</td>
<td>16.2</td>
<td>0</td>
</tr>
<tr>
<td>RECTUM</td>
<td>13.2</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>BLADDER</td>
<td>3.6</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>KIDNEY</td>
<td>2.6</td>
<td>6.9</td>
<td>0</td>
</tr>
<tr>
<td>SPLEEN</td>
<td>2.6</td>
<td>2.3</td>
<td>0</td>
</tr>
<tr>
<td>LIVER</td>
<td>49.5</td>
<td>56.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>
CASUALTY CLEARING STATIONS (CCS):

REGIMENTAL POST ➔ CCS ➔ BASE HOSPITAL

CCS SPECIALIZATION: HEAD and ABDOMEN
CONCOMITTANT MEDICAL ADVANCES ENABLING ABDOMINAL SURGERY:

BLOOD TRANSFUSION:

ANTI-TETANUS SERUM

TRANSPORT, CCS
TYPICAL WWI OPERATING THEATER, BASE HOSPITAL, FRANCE

- **1905**: Clinical Professor, Surgery, Egyptian Government School of Medicine, Cairo
- **1914**: RAMC, Casualty Clearing Station 6, Arras, France
- **1915**: Richard’s Seminal Paper, Br Med J → 9 cases, 2 survived (Both, SB Injuries)
- Sir Anthony Bowlby, Consulting surgeon, BEF → trial, abdominal surgery
- Bowlby mandates early abdominal surgery for trauma in BEF
RICHARD’S CONCLUSIONS, 1915:

- Time to surgery after wounding is paramount
- Availability, experience of surgical teams
- Selection of patients
- Selection of procedure(s)
SIR CUTHBERT SIDNEY WALLACE (1867-1944):

- Familiar with work of Owen Richards
- Favored early laparotomy for ABD WDS
- Urged early evacuation of ABD WDS to CCS
- Avg time from field to CCS was 6-10h
- Approached Surgeon-General MacPherson to allow clinical trials
CONVINCED BY WALLACE TO ALLOW CLINICAL TRIAL, 1914:

AUTOPSIES to DETERMINE CAUSE OF DEATH IN ABD TRAUMA

BOARD OF INQUIRY, MAY 1915

JUNE 1915, MACPHERSON INSTITUTES POLICY OF IMMEDIATE TRANSPORT, ABDOMINAL TRAUMA, to CCS’S

**CONCLUSIONS:**

- **HEMMORRHAGE: CHIEF CAUSE OF DEATH**
- **ABD WDS, ESP. SMALL BOWEL, RARELY HEAL WITHOUT SURGERY**
- **EXPECTANT MANAGEMENT: WRONGLY FOCUSED ON INFECTION/PERITONITIS → OCCURS LATER**
- **BULLETS, CONTRARY TO PREVAILING OPINION, CAUSE:**
  1. MULTIPLE PERFORATIONS OF STOMACH AND BOWEL
  2. EXTENSIVE WOUNDING
ENGLISH SURGEONS PROMOTING EARLY SURGERY FOR ABDOMINAL TRAUMA, WWI

Sir Anthony Bowlby

Sir Cuthbert Sidney Wallace

Sir Gordon Gordon-Taylor
RELATIVE CONTRAINDICATIONS, LAPAROTOMY, IN ABDOMINAL TRAUMA:
(RICHARDS AND GORDON-TAYLOR)

- IMMINENT DEATH
- PT STABLE, ASX
- RUQ ABDOMINAL INJURY
- LUQ ABD WD INVOLVING CHEST
- TIME INTERVAL, INJURY TO TREATMENT $\geq 24h$
- PULSE RATE $> 120$, ↑’d
MORTALITY BY 50%
INDICATIONS FOR LAPAROTOMY IN ABDOMINAL TRAUMA: (FRASER AND DRUMMOND)

- PERFORATING ABDOMINAL INJURY, ESP. GSW
- ABDOMINAL RIGIDTY
- INCREASING PAIN
PREOPERATIVE PREPARATION OF THE ABDOMINAL TRAUMA PATIENT:

- WARMING OF THE PATIENT
- TREDELENBURG POSITION
- ETHER ANESTHESIA
- ADMINISTRATION OF SALINE OR ACACIA GUM SOLUTION DIRECTLY INTO VEINS, SQ, OR PER ANAL INFUSION
- ADMINISTRATION OF BICARBONATE SOLUTIONS IN ACIDOTIC PATIENT
- ONE MG PITUITARY EXTRACT (Fraser, et al.)
- MIDLINE INCISION, FULL EXPLORATION
2. Infection and Peritonitis usually fatal.
3. Multiple Injuries common.
4. Full Exploration of Abdomen mandatory.
5. CCS Records, ABD Surgery. Most Complete Data for MED Research Committee.
DETERMINANTS, OUTCOME of ABDOMINAL SURGERY for TRAUMA, WWI:

- FACILITY ACCESSIBLE WITHIN A HALF HOUR BY MOTOR AMBULANCE
- INTERVAL FROM WOUNDING TO DEFINITIVE MEDICAL CARE PREFERABLY < 12h, IDEALLY < 6h
- MAINTAIN CORE BODY TEMPERATURE
- MORPHINE ≤ ½ gr (32.5 mg) ADMINISTERED IN TRANSPORT
- EXPERIENCED SURGICAL, NURSING STAFF
- “SLOW” vs. “FAST” SURGEONS
- OPERATING THEATER AVAILABLE FOR IMMEDIATE USE
- NUMBER OF ARRIVING CASUALTIES
- FACILITY ABLE TO CONTINUE TREATMENT OF CASUALTY POSTOP
OUTCOME VS. MECHANISM and LOCATION OF ABDOMINAL TRAUMA:

- SMALL BOWEL WDS REQUIRING ONLY SUTURE REPAIR → BEST PROGNOSIS
- ABDOMINAL WDS ASSOC WITH INTRATHORACIC WDS → WORST PROGNOSIS
- UPPER ABD WDS HAVE BETTER PROGNOSIS THAN LOWER ABDOMINAL WDS (BELOW UMBILICUS)
- ABD WDS DUE TO BULLETS AND SHELL/SHRAPNEL HAD SIGNIFICANTLY GREATER MORTALITY THAN WDS DUE TO GRENADES AND BOMB FRAGMENTS
A Clinical and Experimental Study
of
Three Hundred Perforating Wounds
of the Abdomen.

By
J. Fraser, M.D., F.R.C.S.E., Captain R.A.M.C.,
and
Hamilton Drummond, M.B., F.R.C.S.E.,
Captain R.A.M.C.

(Report to the Medical Research Committee)

[With Special Plate]

Some time ago we published a summary of some seventy cases of perforating wounds of the abdominal cavity. We have had an opportunity of increasing our experience of these cases, and the following article is an embodiment of
## SURGICAL MORTALITY RATES PER ABD ORGAN WOUNDED: WWI

(Based in part on Fraser & Drummond, 1917)

<table>
<thead>
<tr>
<th>ORGAN WOUNDED</th>
<th>COMMENTS</th>
<th>SURGICAL MORTALITY RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOMACH</td>
<td>1/3 SUSTAIN ASSOC. INJURIES, NEED TO CHECK POST. WALL</td>
<td>54%</td>
</tr>
<tr>
<td>SMALL BOWEL</td>
<td>SINGLE OR MULTIPLE PERF’S: SUTURE OR RESECTION</td>
<td>64%</td>
</tr>
<tr>
<td>LARGE BOWEL</td>
<td>CLOSURE OF PERFORATION, PRIMARY RESECTION, ± PROX. COLOSTOMY, ± ANASTOMOSIS</td>
<td>56%</td>
</tr>
<tr>
<td>RECTUM</td>
<td>DEBRIDE, DRAIN, DIVERT; (NO ANTIBIOTICS ➔ INC. MORTALITY)</td>
<td>70%</td>
</tr>
<tr>
<td>LIVER, GALLBLADDER</td>
<td>MAJORITY MOST LIKELY KIA; SIMPLE LAC’S SUTURED</td>
<td>42%</td>
</tr>
<tr>
<td>ORGAN WOUNDED</td>
<td>COMMENTS</td>
<td>SURGICAL MORTALITY RATE</td>
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<tr>
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</tr>
<tr>
<td>SPLEEN</td>
<td>EXPECTANT VS. SPLENECTOMY OR REPAIR</td>
<td>35%</td>
</tr>
<tr>
<td>PANCREAS</td>
<td>DRAINAGE ± RESECTION OF DAMAGED SECTION</td>
<td>INSUFFICIENT DATA (unrecognized?)</td>
</tr>
<tr>
<td>KIDNEY</td>
<td>SUTURE OF LAC VS. NEPHRECTOMY, DRAINAGE; R&gt;L KIDNEY MORTALITY</td>
<td>40%</td>
</tr>
<tr>
<td>BLADDER</td>
<td>SUTURE, URETHRAL CATH, SUPR PUBIC CATH</td>
<td>41% (Fraser, 71%)</td>
</tr>
<tr>
<td>MEAN MORTALITY RATE</td>
<td>UNRELIABLE: ? NUMBER OF CASES/ORGAN; ASSOC. INJURIES ?</td>
<td>50%</td>
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</table>
SEMINAL WORKS ON TRAUMA SURGERY, SURGERY OF ABDOMINAL WOUNDS, WWI:
SIR HENRY M.W. GRAY: THE EARLY TREATMENT OF WAR WOUNDS, Aug, 1918, preface:

“I have written nothing on abdominal wounds. . . A surgeon who has mastered the technique of successful excision of an ulcerating cancer of the colon is capable of obtaining as good results as possible if he applies the same principles in the treatment of war wounds of the abdominal organs coupled with those used in combatting spreading peritonitis.”
SUMMARY AND CONCLUSIONS, I:

- ANESTHESIA AND ANTISEPTIC TECHNIQUES/GERM THEORY PARAMOUNT FOR EVOLUTION OF ABDOMINAL SURGERY
- MILITARY SURGERY FOR ABDOMINAL TRAUMA INITIALLY BEHIND THE CURVE
- APPROACH TO SURGERY FOR ABDOMINAL TRAUMA INITIALLY CONSTRAINED BY PRIOR DATA AND ORTHODOXY
- CONCOMITANT ADVANCES, WWI: TRANSFUSIONS, TETANUS, TRANSPORT/“GOLDEN HOUR”
- SPECIALIZED MD’s and CCS’s
SUMMARY AND CONCLUSIONS, II:

- ABD SURGERY IN BEF ALONE RESULTED IN EST. 50-150,000 LIVES SAVED
- TOTAL NUMBER, ACTUAL LAPARTOMIES PERFORMED, UNKNOWN
- INNOVATIONS DEVELOPED IN DEALING WITH ABDOMINAL TRAUMA IN WWI WOULD HAVE REQUIRED A FAR LONGER EVOLUTION IN THE CIVILIAN SECTOR
- LESSONS LEARNED USED SUCCESSFULLY IN COMING CONFLICTS
- LESSONS LEARNED WERE DIRECTLY APPLICABLE TO CIVILIAN SECTOR ➔ EVEN MORE SO TODAY