

Using SAS ® to Create Code for Current Triage Systems during Chemical Incidents

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Abstract

Chemical incidents involving irritant chemicals such as chlorine poses a significant threat to life and require rapid assessment. This paper used data from the first outcomes-level study (R21 NIH) involving an actual mass casualty chemical incident to create code for four triage systems Chemical, Biological, Radiological and Nuclear (CBRN), Sort, Assess, Lifesaving Intervention, Treatment and/or Transport (SALT), Simple Treatment and Rapid Transport (START) and the Emergency Severity Index (ESI). Data used for this paper from six datasets collected by the project team from a 60-ton railroad chlorine leak that occurred in Graniteville, South Carolina in 2005 include patient demographics, exposure estimates, symptoms, outcome categories, and physiological measurements. Data collected for approximately 900 victims of a chlorine leak were merged to generate a research dataset. SAS ® 9.2 used to create code from logic to mimic the triage decision tree yielding classifications for each system.

Introduction

- ❖ Disaster happens in the world each day.
- ❖ Disasters can be categorized to natural and unnatural
- ❖ Mass casualties can overwhelm healthcare capabilities, jeopardizing the lives of victims and healthcare providers alike.
- ❖ No consensus currently exists on standardized indicators for specific aspects of disaster triage response.

Purpose

The purpose of this paper is using SAS to create code for four current triage systems (CBRN, SALT, START and ESI) in a mass causality chemical incident.

Background

- ❖ Six datasets were used from a large chlorine leak in Graniteville (SC).
- ❖ Six datasets were merged to generate a research dataset useful for further analysis.
- ❖ SAS was used to create code for four Current Triage Systems (CBRN, SALT, START, & ESI).
- ❖ New variables were created (Figure 1)
- ❖ Decision logic was developed for four Triage Systems (Figure 2-5).

Results

- ❑ Six percent (n=38) was categorized as red. Also, six percent of the sample did not classify to any categories. (Table1 :START)
- ❑ Twenty-seven of the observations (4.52%) were categorized as level 1 (Table2: ESI).
- ❑ Thirty of the observations (4.75%) were classified as red (Table3: CBRN).
- ❑ Seventy-eight of the observations (12.36 %) was categorized as red (Table4: SALT).

Conclusion

In this paper, SAS used logics to create code for four current triage systems (CBRN, SALT, START and ESI) in mass causality chemical incident. The frequency tables easily were created. SAS is the most powerful statistical software to use in research.

Figure1. Variable Creation

```
EDWALK -- Set to 'Y' when any of the following are true; all others 'N'
  • NOTESFROM = 'Intubated'
  • EDHYPOXIAO = 1 (Yes) or (EDHYPOXIAO is missing and ADHYPOXIAO = 1)
  • EDHYPOXIAR = 1 (Yes) or (EDHYPOXIAR is missing and ADHYPOXIAR = 1)

EDFOLLOW -- Set the same as EDWALK

NORESOURCES -- Set to sum of the following. Range 0 to 6.
  • IF EDO2DELIV NOT IN 'RA' or (EDO2DELIV is missing AND ADO2_DELIV NOT IN 'RA') THEN 1 ELSE 0
  • IF EKGDATE = 1/6/2005 THEN 1 ELSE 0
  • IF BRONCH1DAT = 1/6/2005 THEN 1 ELSE 0
  • IF PFTDATE = 1/6/2005 THEN 1 ELSE 0
  • IF IVDATE = 1/6/2005 THEN 1 ELSE 0
  • NOTESFROM = 'Intubated' THEN 1 ELSE 0

PAIN -- Set to Y if any of the following are true
  • EDTHROATER = Y
  • EDENTOTHER = Y or (EDENTOTHER is missing and ADENTOTHER = Y)
  • EDDERMOTHE = Y or (EDDERMOTHE is missing and ADDERMOTHE = Y)
  • EDDERMBURN = Y or (EDDERMBURN is missing and ADDERM = Y)
  • FirstSx like burn%, Burn%, pain%

CLEXPOSR -- Set to Y if any of the following are true
  • EDEYE = Y or (EDEYE is missing and ADEYE = Y or CCEYE = Y)
  • EDENT = Y or (EDENT is missing and ADEENT = Y or CCENT = Y)
  • EDROUGH = Y or (EDROUGH is missing and ADCOUGH = Y or CCCOUGH = Y)
  • EDWHEEZE = Y or (EDWHEEZE is missing and ADWHEEZE = Y or CCWHEEZING = Y)
  • EDDERMBURN = Y
  • FirstSx = Vomiting, vomiting (with one t and two ts), Nausea, nausea

INJURY -- Set to Y if any of the following are true:
  • CONSULT011 contains 'inj'
  • PRIMAYRDX contains 'inj'

OTHER MISSING VALUE RULES:
  • EDHR -- when missing set to value of ADHR
  • EDRR -- when missing set to value of ADRR
  • EDSYSTOLIC -- when missing set to value of ADSYSTOLIC
  • EDO2SAT -- when missing set to value of ADO2SAT
  • EDRESPDIST -- when missing set to value of ADRESPDIST
```

Figure2. S.T.A.R.T. Simple Treatment and Rapid Transport

```
Inputs: EDWALK, EDFOLLOW, EDHR, EDRSSTOLIC
IF EDWALK = 'Y' THEN GREEN
IF AGE <= 8 THEN TOOYOUNG
  IF EDHR = 0 THEN BLACK
  IF EDHR > 45 OR EDHR < 15 THEN RED
  IF EDHR <= 45 AND EDFOLLOW = N THEN RED
  IF EDHR <= 45 AND EDFOLLOW = Y THEN YELLOW
IF AGE > 8 THEN
  IF EDHR = 0 THEN BLACK
  IF EDHR > 30 OR EDHR < 10 THEN RED
  IF EDHR <= 30 AND EDSYSTOLIC < 70 THEN RED
  IF EDHR <= 30 AND EDSYSTOLIC >= 70 AND EDFOLLOW = N THEN RED
  IF EDHR <= 30 AND EDSYSTOLIC >= 70 AND EDFOLLOW = Y THEN YELLOW
ELSE NOTCLASSIFIED (if we get this, then logic is wrong)
```

Figure4. CBRN Chemical/Biological/Radiation/Nuclear Adults only

```
Inputs: EDWALK, EDFOLLOW, EDHR, EDRESPDIST, CLEXPOSR
IF AGE < 8 THEN TOOYOUNG
IF AGE > 8 THEN
  IF EDWALK = Y AND CLEXPOSR = N THEN T3 (Green)
  IF EDWALK = Y AND CLEXPOSR = Y THEN T2 (Yellow)
  IF EDWALK = N AND EDHR = 0 THEN T4 (Black)
  IF EDWALK = N AND EDRESPDIST = Y THEN T1 (Red)
  IF EDWALK = N AND EDRESPDIST = N AND EDFOLLOW = N THEN T1 (Red)
  IF EDWALK = N AND EDRESPDIST = N AND EDFOLLOW = Y AND CLEXPOSR = Y THEN T1 (Red)
  IF EDWALK = N AND EDRESPDIST = N AND EDFOLLOW = Y AND CLEXPOSR = N THEN T2 (Yellow)
  IF EDWALK = N AND CLEXPOSR = N THEN T2 (Yellow)
ELSE NOTCLASSIFIED
```

Figure5. SALT Sort, Assess lifesaving interventions, treatment and/or transport (Adults)

```
Inputs: EDFOLLOW, EDHR, EDRESPDIST, INJURY, NORESOURCES
IF AGE < 8 THEN TOOYOUNG
IF AGE > 8 THEN
  IF EDHR = 0 THEN DEAD (Black)
  IF EDHR > 0 AND EDRESPDIST = N AND EDFOLLOW = Y THEN NORMAL (Green)
  IF EDHR > 0 AND EDHR > 0 AND EDRESPDIST = N AND EDFOLLOW = Y AND INJURY = Y THEN MINIMAL (Yellow)
  IF (EDHR > 0 OR EDRESPDIST = Y OR EDFOLLOW = N) THEN IMMEDIATE (Red)
  IF (EDRESPDIST = Y OR EDFOLLOW = N) AND NORESOURCES > 0 THEN EXPECTANT (Gray)
ELSE NOTCLASSIFIED
```

Figure3. ESI Emergency Severity Index Adults

```
Inputs: EDFOLLOW, PAIN, EDHR, EDRR, EDSYSTOLIC, EDO2SAT, NORESOURCES
IF AGE < 3 months THEN
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>180 OR EDRR > 50 OR EDO2SAT < 90) AND NORESOURCES > 1 THEN LEVEL 1
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>180 OR EDRR > 50 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = Y THEN LEVEL 2
  IF EDFOLLOW = Y AND EDRESPDIST = N AND (EDHR>180 OR EDRR > 50 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = N THEN LEVEL 3
  IF EDFOLLOW = Y AND EDRESPDIST = N AND NORESOURCES = 1 AND PAIN = N THEN LEVEL 4
  IF EDFOLLOW = Y AND EDRESPDIST = N AND PAIN = N THEN LEVEL 5
IF AGE >= 3 months TO AGE < 3 years THEN
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>160 OR EDRR > 40 OR EDO2SAT < 90) AND NORESOURCES > 1 THEN LEVEL 1
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>160 OR EDRR > 40 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = Y THEN LEVEL 2
  IF EDFOLLOW = Y AND EDRESPDIST = N AND (EDHR>160 OR EDRR > 40 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = N THEN LEVEL 3
  IF EDFOLLOW = Y AND EDRESPDIST = N AND NORESOURCES = 1 AND PAIN = N THEN LEVEL 4
  IF EDFOLLOW = Y AND EDRESPDIST = N AND NORESOURCES = 0 AND PAIN = N THEN LEVEL 5
IF AGE >= 3 AND AGE <= 8 THEN
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>140 OR EDRR > 30 OR EDO2SAT < 90) AND NORESOURCES > 1 THEN LEVEL 1
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>140 OR EDRR > 30 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = Y THEN LEVEL 2
  IF EDFOLLOW = Y AND EDRESPDIST = N AND (EDHR>140 OR EDRR > 30 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = N THEN LEVEL 3
  IF EDFOLLOW = Y AND EDRESPDIST = N AND NORESOURCES = 1 AND PAIN = N THEN LEVEL 4
  IF EDFOLLOW = Y AND EDRESPDIST = N AND NORESOURCES = 0 AND PAIN = N THEN LEVEL 5
IF AGE > 8 THEN
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>100 OR EDHR < 30 OR EDRR < 12 OR EDRR > 20 OR EDSYSTOLIC < 70 OR EDO2SAT < 90) AND NORESOURCES > 1 THEN LEVEL 1
  IF EDFOLLOW = N AND EDRESPDIST = Y AND (EDHR>100 OR EDHR < 30 OR EDRR < 12 OR EDRR > 20 OR EDSYSTOLIC < 70 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = Y THEN LEVEL 2
  IF EDFOLLOW = Y AND EDRESPDIST = N AND (EDHR>100 OR EDHR < 30 OR EDRR < 12 OR EDRR > 20 OR EDSYSTOLIC < 70 OR EDO2SAT < 92) AND NORESOURCES > 1 AND PAIN = N THEN LEVEL 3
  IF EDFOLLOW = Y AND EDRESPDIST = N AND NORESOURCES = 1 AND PAIN = N THEN LEVEL 4
  IF EDFOLLOW = Y AND EDRESPDIST = N AND NORESOURCES = 0 AND PAIN = N THEN LEVEL 5
ELSE NOTCLASSIFIED
```

Table 1. Frequency table result for START

group	Frequency	Percent
green	554	87.80
red	38	6.02
not classified	39	6.18

Table 2. Frequency table result for ESI

level	Frequency	Percent
level 1	27	4.52
level 2	104	17.39
level 3	7	1.17
level 4	460	76.92

Table 3. Frequency table result for CBRN

cgroup	Frequency	Percent
green	514	81.46
red	30	4.75
yellow	87	13.79

Table 4. Frequency table result for SALT

sgroup	Frequency	Percent
green	552	87.48
yellow	1	0.16
red	78	12.36

PART 1: Examples of new variables

```
data two;
  set one;
  *** create new variables ***;
  format bronch1dat mmddyy8.;
  bronch1date=put(bronch1dat,mmddyy8.);

  *** Create index for firstsx ***;
  if firstsx=" " then fsx=.;

  flag1 = index(upcase(firstsx),"BURN");
  flag2 = index (upcase(firstsx),"PAIN");
  flag3 = index (upcase(firstsx),"NAUSEA");
  flag4 = index (upcase(firstsx),"VOMIT");

  *** Create WDWALK and EDFOLLOW ***;
  if notesfrom=" " then notesfrom=.;
  if notesfrom="Intubated" or edhypoxiao=1 or edhypoxiar=1 or person_transport="EMS" then edwalk=0;
  else edwalk=1;
  if notesfrom="Intubated" or edhypoxiao=1 or edhypoxiar=1 or person_transport="EMS" then edfollow=0;
  else edfollow=1;

  *** create the number of resources ;
  if edo2deliv = "RA" then edo2g=0;
  else if edo2deliv = "FM" or edo2deliv="Missing" or edo2deliv="NC" or edo2deliv="NRB" or edo2deliv="Vent" then edo2g=1;
  if ekodate="1/6/2005" then ekg=1;
  else if ekodate="1/7/2005" or ekodate="1/7/2006" or ekodate="1/11/2005" or ekodate="1/8/2005" or ekodate="1/9/2005" then ekg=0;
  if bronch1date="01/06/05" then bron=1;
  else if bronch1date="01/09/05" then bron=0;
  if pftdate="1/6/2005" then pft=1;
  else if pftdate="1/7/2005" or pftdate="1/10/2005" or pftdate="1/11/2005" or pftdate="1/12/2005" or pftdate="1/19/2005" then pft=0;
  if notesfrom="Intubated" then nres=1;
  else nres=0;
  noresources = sum (of edo2g ekg bron pft nres);

  *** Create CLEXPOSR ***;
  if flag3=0 or flag4=0 then fsxc=1;
  else fsxc=0;
  clexposr = sum (of edeye edent edcough edwheeze fsxc);
  if 0<clexposr<5 then clexposr=1;
  else if clexposr=0 then clexposr=0;
```

PART 2: Creating Code for START

```
proc format;
  value groupf 1='green'
               2='black'
               3='red'
               4='yellow'
               5='too young'
               6='not classified' ;

Data start;
  set two;

  if edwalk= 1 then group=1 ;
  else group =.;

  if group=., and (0<=age<9) then do;
    if edrr=0 then group=2; end;

  if group=., and (0<=age<9) then do;
    if (0<edrr<15) or (45<=edrr<92) then group=3;
    if (0<edrr<45) and (edfollow=0) then group=3;
    if (0<edrr<45) and (edfollow=1) then group=4; end;

  if age>8 and group=., then do ;
    if edrr=0 then group=2;
    if (0<edrr<10) or (29<=edrr<92) then group=3;
    if (0<edrr<31) and (0<edsystolic<70) then group=3;
    if (0<edrr<31) and (70<=edsystolic<271) and (edfollow=0) then group=3;
    if (0<edrr<31) and (70<=edsystolic<271) and (edfollow=1) then group=4; end;

  if group=., then group=6;
  format group groupf. ;
run;
```

PART 5: Creating Code for SALT

```
proc format;
  value sgroupf 0='dead'
                1='green'
                2='yellow'
                3='red'
                4='Gray'
                5='too young'
                6='not classified';

Data salt;
  set two;
  if edfollow=1 and edrespdist=0 then edfr=1; else edfr=0;

  if sgroupf=., then do ;
    if edrr=0 then sgroupf=0;
    if edfr=1 and 0<edrr<90 and injury=0 then sgroupf=1; end;
    if sgroupf=., then do;
      if edfr=1 and 0<edrr<92 and 0<edrr<200 and injury=1 then sgroupf=2; end;
    if sgroupf=., then do;
      if edfollow=0 then sgroupf=3;
      if edrespdist=1 then sgroupf=3; end;
    if sgroupf=., then do;
      if edfollow=1 then sgroupf=1; end;
    if sgroupf=., then do;
      if (edfollow=0) or (edrespdist=1) and (0<=noresources<10) then sgroupf=4; end;

  if sgroupf=., then sgroupf=6;

format Sgroup sgroupf. ;
Run;
```

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