CR-171 880
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TECHNICAL INFORMATION RELEASE

management and technical services company

TIR 2114-MED-5011

FROM	**TO**		
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DATE	**CONTRACT NO:**	**T.O. OR A.D. REF:**	**MIS OR OTHER NASA REF:**
05/01/85	NAS9-17151		

SUBJECT

Addendum to the STCAL and LTCAL User's Guide

The expanded calcium model, identified by the acronym LTCAL (for Long-Term Calcium), has been modified extensively in most of the skeletal and phosphorus subsystem models. The material within this addendum updates the modified subsystems (located in appendices H to T) and includes versions of Tables 2 and 3 (simulation input and ouput variables) specific to the LTCAL model.

Susan Brand

Susan Brand

Attachment

/te

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APPENDIX H

SUBROUTINE

PLASCA

(LTCAL)

PURPOSE: To calculate the plasma concentration of calcium given the rates of change in kidney excretion, intestinal secretion and absorption, bone fluid influx and efflux, and solid bone resorption.

```
C
      SUBROUTINE PLASCA
      IMPLICIT REAL (A-Z)
      INCLUDE 'LTCOM.FOR'
      IF (DICA .LE. 0.0001) GO TO 10
      RICA = CAIV/DICA
      TOICA = DT + TOICA
      IF (TOICA .GE. DICA) DICA = 0.0
   10 DCA = RICA + OSCLAS + EFFICA + ALICAL - EXCAL - SECCAL - INFICA
      IF(DCA .LE. 0.0001 .AND. DCA .GE. -0.0001)DCA = 0.0
      TCA = TCA + DCA * DT
      IF(TCA .LE. 0.0001)TCA = 0.0
      ECFV = ECFV + (FLUID - ECFV)/120.0 * DT
      CA = TCA/ECFV
      CAN = CA/2.30
C
      BALANC = EATCAL - FECCAL - EXCAL
      RETURN
      END
```

PLASCA	0.0000E+00	
BALANC	0.0000E+00	CALCIUM BALANCE (MMOLES/MIN)
CA	2.3000E+00	PLASMA CALCIUM CONCENTRATION (MM)
CAIV	0.0000E+00	INFUSION RATE OF CALCIUM (MMOLES/MIN)
CAN	1.0000E+00	PLASMA CALCIUM CONCENTRATION (X-NORM)
DCA	0.0000E+00	DELTA IN PLASMA CALCIUM (MMOLES/MIN)
DICA	0.0000E+00	DURATION OF INFUSION OF CALCIUM (MIN)
ECFV	0.1500E+02	EXTRACELLULAR FLUID VOLUME (L)
FLUID	0.1500E+02	CHANGE IN ECFV (L/MIN)
RICA	0.0000E+00	RATE OF CA INFUSION (MMOLES/MIN)
TCA	0.3450E+02	TOTAL CALCIUM (MMOLES)
TOICA	0.0000E+00	TIME OF CA INFUSION (MIN)

APPENDIX I

SUBROUTINE

EFFLUX

(LTCAL BONE)

PURPOSE: To calculate the rate of flow of calcium from the bone fluid to the plasma. The hormonal regulators are the plasma concentrations of PTH, CTH, and 1,25-(OH)2 D3.

```
C
      SUBROUTINE EFFLUX
      IMPLICIT REAL (A-Z)
       INCLUDE 'LTCOM.FOR'
         CTADE = CTADE + (CTHN - CTADE)/3.0 * DT
         CTAFE = -0.300 * CTADE + 1.300
         IF(CTAFE .LE. 1.0001 .AND. CTAFE .GE. 0.9999)
     1    CTAFE = 1.0
         IF (CTADE .GT. 2.34) CTAFE = 0.60
         IF (CTADE .LE. 0.84) CTAFE = 1.05
         C1ADE = C1ADE + (C1N - C1ADE)/120.0 * DT
         C1AFE = 1.0 * C1ADE
         IF (C1ADE .GE. 1.5) C1AFE = 1.5
         IF (C1ADE .LE. 0.5) C1AFE = 0.5
         PTADE = PTADE + (PTHN - PTADE)/3.0 * DT
         PTAFE = 1.190 * PTADE - 0.190
         IF(PTAFE .LE. 1.0001 .AND. PTAFE .GE. 0.9999)
     1    PTAFE = 1.0
         IF (PTADE .GT. 1.84) PTAFE = 2.0
         IF (PTADE .LE. 0.58) PTAFE = 0.5
         EFFICA = 0.135 * CTAFE * C1AFE * PTAFE
         RETURN
         END
```

```
EFFLUX      0.0000E+00
C1ADE       1.0000E+00   C1N ACTIVITY DELAY ON ICABF EFFLUX (X-N)
C1AFE       1.0000E+00   C1N ACTIVITY FACTOR ON ICABF EFFLUX
CTADE       1.0000E+00   CTH ACTIVITY DELAY, ICABF EFFLUX (NORM)
CTAFE       1.0000E+00   CTH ACTIVITY FACTOR ON ICABF EFFLUX
EFFICA      0.1350E+00   RATE OF ICABF EFFLUX  (MMOLES/MIN)
PTADE       1.0000E+00   PTH ACTIVITY DELAY, ICABF EFFLUX (NORM)
PTAFE       1.0000E+00   PTH ACTIVITY FACTOR ON ICABF EFFLUX
```

APPENDIX J

SUBROUTINE

INFLUX

(LTCAL BONE)

PURPOSE: To calculate the rate of diffusion of calcium from the extracellular fluid to the bone fluid.

```
C
      SUBROUTINE INFLUX
      IMPLICIT REAL (A-Z)
       INCLUDE 'LTCOM.FOR'
C      INTERNAL CONSTANT
C        PBFRES = 0.250  !PLASMA/BONE FLUID RESISTANCE (L/MIN)
         CAPCB = CAPCB + (CA - CAPCB)/3.0 * DT
         INFICA = (CAPCB - ICABF) * 0.250
         IF(INFICA .LE. 0.00001)INFICA = 0.0
         RETURN
         END
```

INFLUX	0.0000E+00	
CAPCB	2.3000E+00	CA IN PERICAPILLARY SPACE OF BONE (MM)
INFICA	0.4250E+00	INFLUX OF ICA INTO BONE FLUID (MMOLE/MIN)

APPENDIX K

SUBROUTINE

AMORPH

(LTCAL BONE)

PURPOSE: To calculate the rate of formation of amorphous calcium - phosphate complexes in the bone fluid. These complexes occur when the concentrations of calcium and phosphate (particularly phosphate) are high. Parathyroid hormone has a positive influence on the formation of these complexes simply because it has an influential effect on the amount of calcium available in the bone fluid.

```
C
      SUBROUTINE AMORPH
      IMPLICIT REAL (A-Z)
C     INTERNAL CONSTANTS:
C        1.05 = INITIAL ICABF * INITIAL PIBF
      INCLUDE 'LTCOM.FOR'
      PTADA = PTADA + (PTHN - PTADA)/300.0 * DT
      PTAFA = 0.595 * PTADA + 0.405
      IF (PTADA .GE. 1.26) PTAFA = 1.15
      IF (PTADA .LE. 0.84) PTAFA = 0.90
      CPPRD = ICABF * PIBF
      SOLPRD = 1.05 * PTAFA
      ASSICA = (CPPRD - SOLPRD)/20.0
      IF(ASSICA .LE. 0.0001 .AND. ASSICA .GE. -0.0001)
     1  ASSICA = 0.00
      TCPCOM = TCPCOM + ASSICA * DT
      IF (TCPCOM .LE. 0.0001 .AND. ASSICA .LT. 0.0001)
     1  ASSICA = 0.0
      RETURN
      END
```

AMORPH	0.0000E+00	
ASSICA	0.0000E+00	CA:PI ASSOCIATION RATE (MMOLE/MIN)
CPPRD	1.0500E+00	BONE FLUID CA:PI PRODUCT (MM*?)
PTADA	1.0000E+00	PTH DELAY FACTOR ON AMORPHOUS BONE
PTAFA	1.0000E+00	PTH ACTIVITY FACTOR AMORPHOUS BONE
SOLPRD	1.0500E+00	SOLUBILITY PRODUCT (MM-L/MIN)
TCPCOM	0.2500E+03	TOTAL CA-PI COMPLEXES (MMOLES)
*	0.0000E+00	

APPENDIX L

SUBROUTINE

BUFFER

(LTCAL BONE)

PURPOSE: To calculate the buffering effects of protein and other nonphosphate substances on calcium in the bone fluid. This effect is a function of the magnitude of change between the current and the normal concentration of ionized bone fluid.

```
C
      SUBROUTINE BUFFER
       IMPLICIT REAL (A-Z)
       INCLUDE 'LTCOM.FOR'
C      INTERNAL VARIABLES
C       CABUFF = 50.0  !CA BUFFERING FACTOR
C       CABMAX = 25.0  !MAX BUFFER CAPABILITY
       CABUF = CABFR * (ICABF - 0.60)/50.0
       IF(CABUF .LE. 0.0001 .AND. CABUF .GE. -0.0001)CABUF = 0.0
       CABFR = (25.0 - ABS(CABUF * DT))/25.0
       IF(CABFR .LE. 0.0001)CABFR = 0.0
       RETURN
       END
```

BUFFER	0.0000E+00	
CABFR	1.0000E+00	FRACTION OF CA BUFFERING REMAINING
CABUF	0.0000E+00	RATE OF CA BUFFERING (MMOLES/MIN)

APPENDIX M

SUBROUTINE

CALCIF

(LTCAL BONE)

PURPOSE: To calculate the rate of calcium accretion (bone formation via the osteoblasts) of solid bone. The hormonal regulator is the plasma concentration of parathyroid hormone.

```
C
      SUBROUTINE CALCIF
      IMPLICIT REAL (A-Z)
       INCLUDE 'LTCOM.FOR'
         DRICBF = DRICBF + (ICABF/0.60 - DRICBF)/60000.0 * DT
         RESAFC = RESAFC + (OCYICA + OSCLAS - RESAFC)/30000.0 * DT
         ACRTDF = ACRTDF + (ACRETF - ACRTDF)/14400.0
         NACRET = ACRTDF * RESAFC
         PTADC = PTADC + (PTHN - PTADC)/120.0 * DT
         PTAFC = 1.19 * PTADC - 0.19
         IF (PTADC .GE. 1.75) PTAFC = 1.89
         IF (PTADC .LT. 0.64) PTAFC = 0.58
         ACRET = NACRET * DRICBF/PTAFC
         RETURN
         END
```

CALCIF	0.0000E+00	
ACRET	0.3000E+00	RATE OF ACCRETION (CALCIF) (MMOLE/MIN)
ACRETF	1.0000E+00	ACRETION FACTOR
ACRTDF	1.0000E+00	ACRETION DELAY FACTOR
DRICBF	1.0000E+00	DELAYED RATIO OF ICABF FROM NORM (X-NORM)
NACRET	0.3000E+00	NORMAL RATE OF ACCRETION (MMOLES/MIN)
PTADC	1.0000E+00	PTH ACTIVITY DELAY, BONE CALCIF. (X-NORM)
PTAFC	1.0000E+00	PTH ACTIVITY FACTOR ON BONE CALCIF.
RESAFC	0.3000E+00	RESORP ACTIV FACTOR ON CALCIF (MMOLE/MIN)

APPENDIX N

SUBROUTINE

OSLYS

(LTCAL BONE)

PURPOSE: To calculate the rate of bone resorption due to osteocytic osteolysis. Parathyroid hormone is the only hormonal regulator.

```
C
      SUBROUTINE OSLYS
      IMPLICIT REAL (A-Z)
       INCLUDE 'LTCOM.FOR'
         PTADO = PTADO + (PTHN - PTADO)/600.0 * DT
         PTAFO = 0.119 * PTADO + 0.881
         IF (PTADO .LT. 1.09) PTAFO = 1.0
         IF (PTADO .GE. 8.40) PTAFO = 1.88
         OCYICA = 0.01 * PTAFO
         RETURN
         END
```

OSLYS	0.0000E+00	
OCYICA	0.0100E+00	RATE OF OSTEOCYTIC OSTEOLYSIS (MMOLE/MIN)
PTADO	1.0000E+00	PTH ACTIVITY DELAY, OSTEOLYSIS (X-NORM)
PTAFO	1.0000E+00	PTH ACTIVITY FACTOR, OSTEOLYSIS

APPENDIX O

SUBROUTINE

FLUID

(LTCAL BONE)

PURPOSE: To calculate the concentration of ionized calcium in the bone fluid.

```
C
      SUBROUTINE BFLUID
      IMPLICIT REAL (A-Z)
      INCLUDE 'LTCOM.FOR'
      DICABF = INFICA + OCYICA - ASSICA - EFFICA - ACRET - CABUF
      IF(DICABF .LE. 0.0001 .AND. DICABF .GE. -0.0001)
     1 DICABF = 0.0
      TICABF = TICABF + DICABF * DT
      IF(TICABF .LE. 0.0001)TICABF = 0.0
      ICABF = TICABF/VDICA
      RETURN
      END
```

BFLUID	0.0000E+00	
DICABF	0.0000E+00	DELTA IN TICABF (MMOLES/MIN)
ICABF	0.6000E+00	IONIZED CA IN THE BONE FLUID (MM)
TICABF	0.2100E+00	TOTAL ICABF (MMOLES)
VDICA	0.3500E+00	VOLUME OF DISTRIBUTION, ICABF (L)

APPENDIX P

SUBROUTINE

SOLID

(STCAL BONE)

PURPOSE: To calculate the rate of change of calcium in the solid bone given the rates of bone accretion, resorption, and osteocytic osteolysis; and the effects of parathyroid hormone, calcitonin, and 1,25-(OH)2 vitamin D on osteoclastic activity and numbers.

```
C
      SUBROUTINE SOLID
      IMPLICIT REAL (A-Z)
      INCLUDE 'LTCOM.FOR'
      CTADSB = CTADSB + (CTHN - CTADSB)/858.0
      CTAFSB = (-0.30) * CTADSB + 1.30
      IF (CTADSB .GT. 2.33) CTAFSB = 0.60
      IF (CTADSB .LE. 0.83) CTAFSB = 1.05
      C1ADSB = C1ADSB + (C1N - C1ADSB)/60000.0
      C1AFSB = 1.0 * C1ADSB
      IF (C1ADSB .GE. 1.5) C1AFSB = 1.5
      IF (C1ADSB .LE. 0.50) C1AFSB = 0.5
      PTADSB = PTADSB + (PTHN - PTADSB)/858.0
      PTAFSB = 0.238 * PTADSB + 0.70
      IF (PTADSB .GE. 8.40) PTAFSB = 2.7
      IF (PTADSB .LE. 1.26) PTAFSB = 1.0
      PTADON = PTADON + (PTHN - PTADON)/150000.0
      PTAFON = 0.238 * PTADON + 0.70
      IF (PTADON .GE. 8.40) PTAFON = 2.70
      IF (PTADON .LT. 1.26) PTAFON = 1.0
      RSORPD = RSORPD + (RSORPF - RSORPD)/1440.0
      OSCLAS = 0.29*CTAFSB* C1AFSB * PTAFSB * PTAFON * SBONER * RSORPD
      SBONED = ACRET - OCYICA - OSCLAS
      IF(SBONED .LE. 0.0001 .AND. SBONED .GE. -0.0001)
     1 SBONED = 0.0
      SBONET = SBONET + SBONED * DT
      SBONER = SBONET/25000.0
      RETURN
      END
```

SOLID	0.0000E+00	
C1ADSB	1.0000E+00	C1N ACTIVITY DELAY ON SOLID BONE (X-N)
C1AFSB	1.0000E+00	C1N ACTIVITY FACTOR ON SOLID BONE
CTADSB	1.0000E+00	CTH ACTIVITY DELAY ON SOLID BONE (X-NORM)
CTAFSB	1.0000E+00	CTH ACTIVITY FACTOR ON SOLID BONE
PTADON	1.0000E+00	PTH ACTIVITY DELAY, OSTEOCLAST # (X-NORM)
PTADSB	1.0000E+00	PTH ACTIVITY DELAY ON SOLID BONE (X-NORM)
PTAFON	1.0000E+00	PTH ACTIVITY FACTOR ON OSTEOCLAST #
PTAFSB	1.0000E+00	PTH ACTIVITY FACTOR ON SOLID BONE
OSCLAS	0.2900E+00	CA RESORPTION VIA OSTEOCLASTS (MMOLE/MIN)
RSORPD	1.0000E+00	RESORPTION DELAY FACTOR
RSORPF	1.0000E+00	RESORPTION FACTOR
SBONED	0.0000E+00	DELTA IN SOLID BONE CALCIUM (MMOLE/MIN)
SBONER	1.0000E+00	RATIO OF TOTAL TO NORMAL SOLID BONE CA
SBONET	0.2500E+05	TOTAL SOLID BONE CALCIUM (MMOLES)

APPENDIX Q

SUBROUTINE

KIDPI

(LTCAL PHOSPHOROUS)

PURPOSE: To calculate the rate of urine phosphorous excretion. The model is based upon a classical mathematical description of kidney function: excretion = glomerular filtration - reabsorption. The rate of reabsorption has a maximum that is affected by the plasma concentration of parathyroid hormone.

```
C
      SUBROUTINE KIDPI
      IMPLICIT REAL (A-Z)
      INCLUDE 'LTCOM.FOR'
      GFPI = PI * GFR
      REABPI = GFPI - 0.4
      PTACKP = PTACKP + (PTHN - PTACKP)/3.0 * DT
      REABMX = -2.5 * PTACKP + 12.0
      IF (PTACKP .GE. 1.2) REABMX = 9.0
      IF (GFPI .GE. REABMX) REABPI = REABMX
      EXPHO = GFPI - REABPI
      RETURN
      END
```

KIDPI	0.0000E+00	
EXPHO	0.4000E+00	RATE OF PI EXCRETION (MMOLES/MIN)
GFR	7.5200E+00	GLOMERULAR FILTRATION RATE (L/MIN)
GFPI	9.4000E+00	RATE OF PI FILTRATION (MMOLES/MIN)
PTACKP	1.0000E+00	PTH ACTIVITY ON PI REABSORPTION (NG/ML)
REABMX	9.5000E+00	MAX PI REABSORPTION RATE (MMOLES/MIN)
REABPI	9.0000E+00	REABSORPTION RATE OF PI (MMOLES/MIN)

APPENDIX R

SUBROUTINE

SOFTTI

(LTCAL PHOSPHOROUS)

PURPOSE: To calculate the flow of phosphorous into and out of the soft tissues. The plasma calcium concentration influences this rate.

```
C
      SUBROUTINE SOFTTI
      IMPLICIT REAL (A-Z)
      INCLUDE 'LTCOM.FOR'
      CATIPI = CATIPI + (CA - 2.30 - CATIPI)/6.0 * DT
      IF(CATIPI .LE. 0.0001 .AND. CATIPI .GE. -0.0001)
     1 CATIPI = 0.0
      DTISPI = 6.9 * CATIPI
      IF(CATIPI .GE. 1.15) DTISPI = 7.93
      IF(CATIPI .LE. 0.0001) DTISPI = 0.0
      TISFAC = (20.0 - ABS(DTISPI * DT))/20.0
      TISPI = DTISPI * TISFAC
      IF(TISPI .LE. 0.0001 .AND. TISPI .GE. -0.0001)TISPI = 0.0
      RETURN
      END
```

SOFTTI	0.0000E+00	
CATIPI	0.0000E+00	CA ACTIVITY ON TISSUE PI (MMOLE/MIN)
DTISPI	0.0000E+00	DELTA TISSUE PI (MMOLE/MIN)
TISFAC	1.0000E+00	RATIO OF REMAINING/MAX TISSUE PI
TISPI	0.0000E+00	TISSUE PI REMOVED OR STORED (MMOLE/MIN)

APPENDIX S

SUBROUTINE

BONEPI

(LTCAL PHOSPHOROUS)

PURPOSE: To calculate the amount of phosphorous in the bone and the concentration of phosphorous in the bone fluid at any given time. Calcium bone activity is closely related to phosphorous bone activity, and calcitonin plays a regulatory role.

```
C
      SUBROUTINE BONEPI
      IMPLICIT REAL (A-Z)
       INCLUDE 'LTCOM.FOR'
         ACRPHO = ACRET * 0.25
         OCYPI = OCYICA * 0.25
         ASSPI = ASSICA * 1.0
         IF(ASSPI .LE. 0.0001 .AND. ASSPI .GE. -0.0001)
     1     ASSPI = 0.0
         CTADPI = CTADPI + (CTHN - CTADPI)/3.0 * DT
         CTAFPI = 1.19 * CTADPI - 0.19
         IF (CTADPI .GE. 1.68) CTAFPI = 1.80
         IF (CTADPI .LE. 0.83) CTAFPI = 0.80
         INFPI = 0.425 * CTAFPI
         PIBFD = PIBFD + (PIBF - PIBFD)/120.0 * DT
         EFFPI = (PIBFD - PIPCB) * 0.705
         DPIBF = OCYPI + INFPI - ACRPHO - ASSPI - EFFPI
         IF(DPIBF .LE. 0.0001 .AND. DPIBF .GE. -0.0001)
     1     DPIBF = 0.0
         TPIBF = TPIBF + DPIBF * DT
         PIBF = TPIBF/0.10
         PIPCB = PIPCB + (PI - PIPCB)/120.0 * DT
         RETURN
         END
```

BONEPI	0.0000E+00	
ACRPHO	0.0750E+00	ACCRETION RATE OF PHOSPHATE (MMOLES/MIN)
ASSPI	0.0000E+00	PI ASSOCIATION, CA:PI COMPLEX (MMOLE/MIN)
CTADPI	1.0000E+00	CTH ACTIVITY DELAY ON PI INFLUX (NG/ML)
CTAFPI	1.0000E+00	CTH ACTIVITY FACTOR ON PI INFLUX (X-N)
DPIBF	0.0000E+00	DELTA IN PI CONC IN BONE FLUID (MMOLES)
EFFPI	0.3525E+00	RATE OF PHOSPHOROUS EFFLUX (MMOLES/MIN)
INFPI	0.4250E+00	RATE OF PHOSPHOROUS INFLUX (MMOLES/MIN)
OCYPI	0.0025E+00	RATE PI OSTEOCYTIC OSTEOLYSIS (MMOLE/MIN)
PIBF	1.7500E+00	PHOSPHATE CONC IN BONE FLUID (MM)
PIBFD	1.7500E+00	DELAY IN PIBF CHANGES
PIPCB	1.2500E+00	PLASMA:PERICAPILLARY PI DIFFERENCE (MM)
TPIBF	0.1750E+00	TOTAL PI IN BONE FLUID (MMOLES)

APPENDIX T

SUBROUTINE

PLASPI

(LTCAL PHOSPHOROUS)

PURPOSE: To calculate the plasma concentration of phosphorous given the intestinal absorption and secretion rates, the kidney excretion rate, and the bone and soft tissue efflux and influx rates.

```
C
      SUBROUTINE PLASPI
      IMPLICIT REAL (A-Z)
      INCLUDE 'LTCOM.FOR'
     IF (DIPI .LE. 0.0001) GO TO 10
     RIPI = PIIV/ECFV/DIPI
     TOIPI = DT + TOIPI
     IF (TOIPI .GE. DIPI) DIPI = 0.0
  10 DPI = RIPI + TISPI + ALIPHO + EFFPI + RESORP
    1 - INFPI - EXPHO -SECPHO
     IF(DPI .LE. 0.0001 .AND. DPI .GE. -0.0001)DPI = 0.0
      TPI = TPI + DPI * DT
      PI = TPI/ECFV
      IF (PI .LE. 0.0001) PI = 0.0
      PIN = PI/1.25
      RETURN
      END
```

PLASPI	0.0000E+00	
ALIPHO	0.8000E+00	RATE OF PI ABSORPTION (MMOLES/MIN)
DIPI	0.0000E+00	DURATION OF PI INFUSION (MIN)
DPI	0.0000E+00	DELTA IN PLASMA PI CONC (MMOLES)
PI	1.2500E+00	PLASMA PHOSPHATE CONCENTRATION (MM)
PIIV	0.0000E+00	RATE OF PHOSPHATE INFISION (MMOLES/MIN)
PIN	1.0000E+00	PLASMA PHOSPHATE CONCENTRATION (X-NORM)
RESORP	0.0725E+00	RATE OF PI BONE RESORPTION (MMOLE/MIN)
RIPI	0.0000E+00	RATE OF PI INFUSION (MM/ML/MIN)
SECPHO	0.4000E+00	RATE OF GIT PI SECTRETION (MMOLE/MIN)
TOIPI	0.0000E+00	TIME OF PI INFUSION (MIN)
TPI	0.1875E+02	TOTAL PLASMA PHOSPHATE (MMOLES)

TABLE 2: SIMULATION INPUT VARIABLES FOR LTCAL. LIST OF VARIABLE NAMES, VALUES, AND DEFINITIONS

Variable Name	Initial Value	Variable Definition
ORGAN FUNCTION FACTORS		
KIDF	0.10000E+01	Kidney Excretion Function Factor
GUTFAC	0.10000E+01	Intestine Function Factor
MOTFAC	0.10000E+01	Intestinal Mobility Function Factor
SECFAC	0.10000E+01	Intestinal Secretion Function Factor
GSFF	0.10000E+01	PTH Glandular Storage Function Factor
PSFF	0.10000E+01	PTH Secretion Function Factor
DAFF	0.10000E+01	Vitamin D Absorption Function Factor
KXFF	0.10000E+01	Kidney Hydroxylation Function Factor (Vitamin D)
LXFF	0.10000E+01	Liver Hydroxylation Function Factor (Vitamin D)
CSFF	0.10000E+01	CT Secretion Function Factor
RSORPF	0.10000E+01	Bone Resorption Function Factor
ACRETF	0.10000E+01	Bone Accretion Function Factor
DIETARY INTAKES		
EATCAL	0.15270E+01	Dietary Intake of Calcium (mmoles/min)
DIN	0.36750E+02	Dietary Intake of VIT D (nmol)
DIN2	0.00000E+00	Dietary Intake of 25-(OH) Vitamin D (nmol)
ALIPHO	0.80000E+00	Dietary Intake of Phosphorus (mmoles/min)
INFUSION QUANTITIES AND DURATIONS		
CAIV	0.00000E+00	Infusion of Calcium (mmoles)
DICA	0.00000E+00	Duration of Infusion of Calcium (min)
PTIV	0.00000E+00	Infusion of PTH (ng)
DIPT	0.00000E+00	Duration of PTH Infusion (min)
IVD3	0.00000E+00	Dose of Injected VIT D3 (pmol)
IV25	0.00000E+00	Dose of Injected 25-(OH)VIT D (pmol)
IV1	0.00000E+00	Dose of Injected 1,25-(OH)2VIT D (pmol)
DID3	0.00000E+00	Duration of Vitamin D Infusions (Min)
CTIV	0.00000E+00	Infusion of Calcitonin (ng)
DICT	0.00000E+00	Duration of Calcitonin Infusion (min)
DIPI	0.00000E+00	Duration of Phosphorus Infusion (min)
PIIV	0.00000E+00	Rate of Phosphorus Infusion (mmoles/min)
OTHERS		
FLUID	0.15000E+02	Extracellular Fluid Volume (L)
GFR	0.75200E+01	Glomerular Filtration Rate (L/min)

TABLE 3: SIMULATION OUTPUT VARIABLES FOR LTCAL: VARIABLE NAMES, VALUES, AND DEFINITIONS. (X-NORM VALUES ARE CALCULATED BY DIVIDING THE CURRENT VARIABLE VALUE BY THE INITIAL DATA BASE VARIABLE VALUE.)

Variable Name	Initial Value	Variable Definition
EXCAL	0.52000E+00	Rate of Urine CA Excretion (mmoles/min)
EXPHO	0.40000E+00	Rate of Urine PI Excretion (mmoles/min)
ALICAL	0.10070E+01	Rate of Intestinal CA Absorption (mmoles/min)
FECCAL	0.10070E+01	Rate of FECCAL CA Excretion (mmoles/min)
SECCAL	0.48700E+00	Rate of Intestinal CA Secretion (mmoles/min)
ACRET	0.30000E+00	Rate of CA Accretion (mmoles/min)
ACRPHO	0.30000E+00	Rate of PI Accretion (mmoles/min)
EFFICA	0.13500E+00	Rate of ICA Efflux From Bone Fluid (mmoles/min)
EFFPI	0.3525E0+00	Rate of PI Efflux From Bone Fluid (mmoles/min)
OCYICA	0.01000E+00	Rate of ICA Osteocytic Osteoclysis (mmoles/min)
OCYPI	0.00250E+00	Rate PI Osteocytic Osteolysis (mmoles/min)
OSCLAS	0.29000E+00	Rate of Osteoclastic CA Resorption (mmoles/min)
RESORP	0.07250E+00	Rate of Osteoclastic PI Resorption (mmoles/min)
INFICA	0.42500E+00	Rate of ICA Influx into Bone Fluid (mmoles/min)
INFPI	0.42500E+00	Rate of PI Influx Into Bone Fluid (mmoles/min)
ICABF	0.60000E+00	Ionized CA in the Bone Fluid (mm)
PIBF	0.17500E+01	Phosphorus in Bone Fluid (mm)
BALANC	0.00000E+00	CA Balance (mmoles/min)
CA	0.23000E+01	Plasma Calcium Concentration (mm)
CAN	0.10000E+01	Plasma Calcium Concentration (X-norm)
PI	0.25000E+00	Plasma Phosphate Concentration (mm)
PIN	0.10000E+01	Plasma Phosphate Concentration (X-norm)
PTH	0.25500E+00	Plasma Concentration of PTH (ng/ml)
PTHN	0.10000E+01	Plasma PTH (X-NORM)
CD3	0.65000E+01	Plasma Concentration of VIT D3 (6.5 Pmol/ml)
CD3N	0.10000E+01	CD3 Normalized (X-NORM)
C25	0.65000E+02	Plasma Conc. of 25-(OH) Vitamin D (65.0 pmol/ml)
C25N	0.10000E+01	C25 Normalized (X-norm)
C24	0.65000E+01	Plasma Conc. of 24,25-$(OH)_2$ Vitamin D (6.5 pmol/ml)
C24N	0.10000E+01	C24 Normalized (X-norm)
C125	0.80000E+01	Plasma Conc. of 1,25-$(OH)_2$ Vitamin D (0.08 pmol/ml)
C1N	0.10000E+01	C125 Normalized (X-norm)
CTH	0.49000E-01	Plasma Concentration of Calcitonin (ng/ml)
CTN	0.10000E+01	Plasma Calcitonin (X-norm)