Appendix F

The Evaluation Queries

This appendix contains the 23 queries that the medical domain experts formulated based on the clinical data set in Appendix C. The domain experts formulated each query in natural language. I subsequently encoded each query in the ReFER query language, based on the FER schema that I designed for the clinical data set and I used the queries for the evaluation experiment. The ReFER encoding of each query follows the natural-language formulation of the query in the following sections. In certain cases, I changed the meaning of the query slightly when I encoded it in the ReFER language. These changes usually entailed adding date information to the query that the domain expert had omitted. In several cases, however, the query was modified in order to be compatible with the FER schema. All changes to the original natural-language queries are noted and explained below. The original query appears in bold-faced text and my ReFER translation of the query appears in fixed-width text.

1. What are the admission diagnoses for Jessica Hepburn?

```
[ name-of-disease(admit-dgx-of(ie)) | (ie:Inpatient_Encounter),
                                       (pt:Patient) AND
                                       Patient-Encounter(pt,ie) AND
                                       last-name-of(pt) = "Hepburn" AND
                                       first-name-of(pt) = "Jessica" ]
```

2. What are the medications for Jessica Hepburn at the time she was admitted to the ICU?

```
[  name-of-med(m) | (m:Medications),(pt:Patient),
                    (ie:Inpatient_Encounter) AND
                    Patient-Encounter(pt,ie) AND
                    ew^^ward-of-encounter(ie) = "ICU" AND
                    pm^^Patient-Medication(pt,m) AND
                    start-time-of-med(pm) <= start-time-of-ward(ew) AND
                      (stop-time-of-med(pm) >= start-time-of-ward(ew) OR
                       stop-time-of-med(pm) IS NULL ) AND
                    last-name-of(pt) = "Robik" ]
```

3. What are the allergies for Anna Robik?

```
[ drug-allergy-of(pt) | (pt:Patient) AND
                        last-name-of(pt) = "Robik" AND
                        first-name-of(pt) = "Anna" ]
```

4. At 8:00 a.m. , what is the lowest pO2 for Jessica Hepburn?

```
MIN ([value-of-lab(po2) | (po2:PaO2),(pt:Patient) AND
                          Patient-Lab_Tests(pt,po2) AND
                          datetime-of-lab(po2) <= "1993/08/17 0800" AND
                          last-name-of(pt) = "Hepburn" AND
                          first-name-of(pt) = "Jessica" ] )
```

Note: I modified this query to retrieve the lowest p02 at 8:00 a.m. *on the day of August 17, 1993.*

5. What is the mean O2 saturation for Jessica Hepburn over the last 24 hours at 8:00 a.m. ?

```
AVG( [ value-of-lab(ao2s) | (ao2s:Arterial_O2_Sat),(pt:Patient) AND
                            Patient-Lab_Tests(pt,ao2s) AND
                            datetime-of-lab(ao2s) <= "1993/08/17 0800"
                                    AND
                            datetime-of-lab(ao2s) >= "1993/08/16 0800"
                                    AND
                            last-name-of(pt) = "Hepburn" AND
                            first-name-of(pt) = "Jessica" ] )
```

Note: I modified this query to retrieve the mean 02 saturation over the previous 24 hours at 8:00 a.m. *on the day of August 17, 1993.*

6. What are the last laboratory results at 8:00 a.m. for Anna Robik?

Note: I could not encode this query because the ReFER query language currently has no *ordering* operator to determine the latest date in a sequence of dates.

7. What is the total input for the past 24 hours at 9:00 a.m. and the total output for the past 24 hours for Anna Robik?

```
[ SUM([value-of-parm(i) | (i:Volume_In) AND Patient-Parameter(pt,i) AND
                               time-of-parm(i) <= "1993/04/11 0900" AND
                               time-of-parm(i) >= "1993/04/10 0900" ]),
  SUM([value-of-parm(o) | (o:Volume_Out) AND Patient-Parameter(pt,o) AND
                               time-of-parm(o) <= "1993/04/11 0900" AND
                               time-of-parm(o) >= "1993/04/10 0900" ])
          | (pt: Patient) AND last-name-of(pt) = "Robik" AND
                              first-name-of(pt) = "Anna" ]
```

Note: This query was modified to compute the total input and output for the past 24 hours at 9:00 a.m. *on April 11, 1993.*

8. What were the last three arterial blood gas readings for Jessica Hepburn at 1:00 p.m. 8/17/93?

Note: I could not encode this query because the ReFER query language has no ordering operator to compute the last *N* instances in a set.

9. What is Jessica Hepburn's average respiratory rate over the past 12 hours at 8:00 a.m.?

```
AVG ( [ value-of-parm(rr) | (rr:Respiratory_Rate),(pt:Patient) AND
                             Patient-Parameter(pt,rr) AND
                             time-of-parm(rr) <= "1993/08/17 0800" AND
                             time-of-parm(rr) >= "1993/08/16 2000" AND
                             last-name-of(pt) = "Hepburn" AND
                             first-name-of(pt) = "Jessica" ] )
```

Note: I modified this query to retrieve the average respiratory rate over the previous 12 hours at 8:00 a.m. *on the day of August 17, 1993.*

10. What is Anna Robik's maximum temperature over the past 12 hours at 8:00 a.m. on May 11, 1994?

```
MAX ([ value-of-parm(t) | (t:Temperature),(pt:Patient) AND
                           Patient-Parameter(pt,t) AND
                           last-name-of(pt) = "Robik" AND
                           first-name-of(pt) = "Anna" AND
                           time-of-parm(t) <= "1993/04/11 0800" AND
                           time-of-parm(t) >= "1993/04/10 2000" ] )
```

11. Who is the attending physician for Anna Robik?

```
[ first-name-of(md),
  last-name-of(md)   | (md:Physician),(pt:Patient) AND
                      Patient-Physician(pt,md) AND
                      last-name-of(pt) = "Robik" AND
                      first-name-of(pt) = "Anna" ]
```

Note: Because the FER schema does not distinguish between attending and consulting physicians, I modified this query to retrieve *all* of the physicians for Anna Robik.

12. What is Jessica Hepburn's home phone number?

```
[ home-phone-of(pt) | (pt:Patient) AND
                      last-name-of(pt) = "Hepburn" AND
                      first-name-of(pt) = "Jessica" ]
```

13. Names of all patients who have pH < 7.25 in last week

```
[ last-name-of(pt),
  first-name-of(pt) | (ph:Arterial_Ph), (pt:Patient) AND
                       Patient-Lab_Tests(pt,ph) AND
                       datetime-of-lab(ph) >= "1993/08/11 0000" AND
                       value-of-lab(ph) < 7.25 ]
```

Note: I modified this query to retrieve the patients with a pH < 7.25 in the previous week *as of August 17, 1993*.

14. Names of all patients currently on Lasix and their lowest value of potassium within the last 24 hours

```
[  last-name-of(pt),
   MIN( [ value-of-lab(k) | (k:Serum_K) AND
                             Patient-Lab_Tests(pt,k) AND
                             datetime-of-lab(k) >= "1993/05/25 0000" ] )
   | (pt:Patient),(med:Ranitidine) AND
          pm^^Patient-Medication(pt,med) AND
          stop-time-of-med(pm) IS NULL ]
```

Note: Because none of the patients in the data set were on Lasix, I modified this query to find the lowest potassium value for the patients on *ranitidine* over the last 24 hours *as of midnight on May 25, 1993.*

15. Names of any patients whose current weight is 4 kg less than their admission weight or 4 kg greater than their admission weight

Note: I could not encode this query because no weight data was represented in the FER schema.

16. Name of any patient who currently has HCT < 30 and is not on ranitidine or cimetidine or an antacid

```
[ last-name-of(pt) | (pt:Patient) AND
                     EXISTS [ (hct:HCT) AND
                              Patient-Lab_Tests(pt,hct) AND
                              value-of-lab(hct) < 30 AND
                              datetime-of-lab(hct) >= "5/25/1993 00:00" ]
                        AND
                     NOT EXISTS [ (med:Antacids) AND
                                  pm^^Patient-Medication(pt,med) AND
                                  stop-time-of-med(pm) IS NULL ] ]
```

17. Names of all patients on a medication to which they are allergic

Note: I could not encode this query because the ReFER query language has no constructs for relating data and metadata (i.e. there is no operator to test if a medication prescribed to a patient is *an instance of* a class of medications to which the patient is allergic).

18. Provide the ABG and respiratory rate within 6 hours before and 1 hour after for any patient receiving mechanical ventilation

Note: I could not encode this query because the ReFER query language has no constructs for performing arithmetic operations on temporal data.

19. How many hours after Anna is placed on cefotetan does her temperature fall below 101?

Note: I could not encode this query because the ReFER query language has no constructs for performing arithmetic operations on temporal data.

20. Name of any patient taking Digoxin and Quinidine on the same day

Note: I could not encode this query because the semantics of "on the same day" are ambiguous: within the same 24 hour period or on the same calendar day?

21. Name of any patient on Theodur with a theophylline level < 10 or > 20

```
[ last-name-of(pt),
  first-name-of(pt) | (pt:Patient), (med:Theodur) AND
                       pm^^Patient-Medication(pt,med) AND
                       stop-time-of-med(pm) IS NULL AND
                       EXISTS [ (ta:Theophylline_Assay) AND
                                Patient-Lab_Tests(pt,ta) AND
                                datetime-of-lab(ta) >
                                            start-time-of-med(pm) AND
                                ( value-of-lab(ta) < 10   OR
                                  value-of-lab(ta) > 20 ) ] ]
```

22. Name of any patient currently on a ventilator who has gone > 4 hours without an ABG reading

```
[ last-name-of(pt) | (pt:Patient) AND
                      NOT EXISTS [ (abg:Blood_Gases) AND
                                   Patient-Lab_Tests(pt,abg) AND
                                   datetime-of-lab(abg) >=
                                   "1993/05/25 1600" ]   ]
```

Note: I modified this query to retrieve the last name of any patient who has gone > 4 hours without an ABG reading *as of 4:00 p.m. on May 25, 1993*, because no data regarding ventilator status was available in the FER schema..

23. Name of any patient with temperature > 101 who has not had a WBC within the last 8 hours

```
[ last-name-of(pt) | (pt:Patient),(t:Temperature) AND
                     Patient-Parameter(pt,t) AND
                     value-of-parm(t) >= 38.3 AND
                     time-of-parm(t) >= "8/16/1993 20:00" AND
                     NOT EXISTS [ (lab:WBC) AND
                                  Patient-Lab_Tests(pt,lab) AND
                                  datetime-of-lab(lab) >
                                                "8/16/1993 16:00"] ]
```

Note: I modified this query to retrieve the last name of any patient with a temperature > 38.3 centigrade who has not had a white blood count within the last 8 hours *as of 4:00 p.m. on August 16, 1993*.