A Physician's Decision-making Oriented Model of Cancer Chemotherapy toward Computer-assisted Chemotherapy Planning and Alerting System.

Yoshimasa Kawazoe [1] , Toru Endo [2] , Yutaka Mitsuishi [2] , Kengo Miyo [3], Kazuhiko Ohe [1]

[1] Department of Medical Informatics and Economics, the University of Tokyo, Japan

[2] FUJITSU LIMITED, Japan

[3] Department of Planning, Information and Management, the University of Tokyo Hospital, Japan

Objective

- **Developing a computer-assisted cancer chemotherapy planning and alerting system.**
  - To prevent iatrogenic injury.
  - To improve patient safety and quality of care.

For that purpose…

- **Presenting a model of chemotherapy planning.**
  - Emphasizing physician's decision-making process.
  - Representing associated heuristic knowledge.

Methods

- **Analyzing**
  - Analyze an information structure of chemotherapy regimens [1] and categorize it.
  - Clarify typical scenes of decision-making through discussing with physicians.
- **Representing**
  - Document out our models using Unified Modeling Language [2].
- **Developing**
  - Develop a prototype system based on the proposed models.

Results

- **Classified and expressed the knowledge of chemotherapy into three categories.**

  a. Entities of chemotherapy.

     Entity model of chemotherapy.

  b. Process of chemotherapy work-flow.

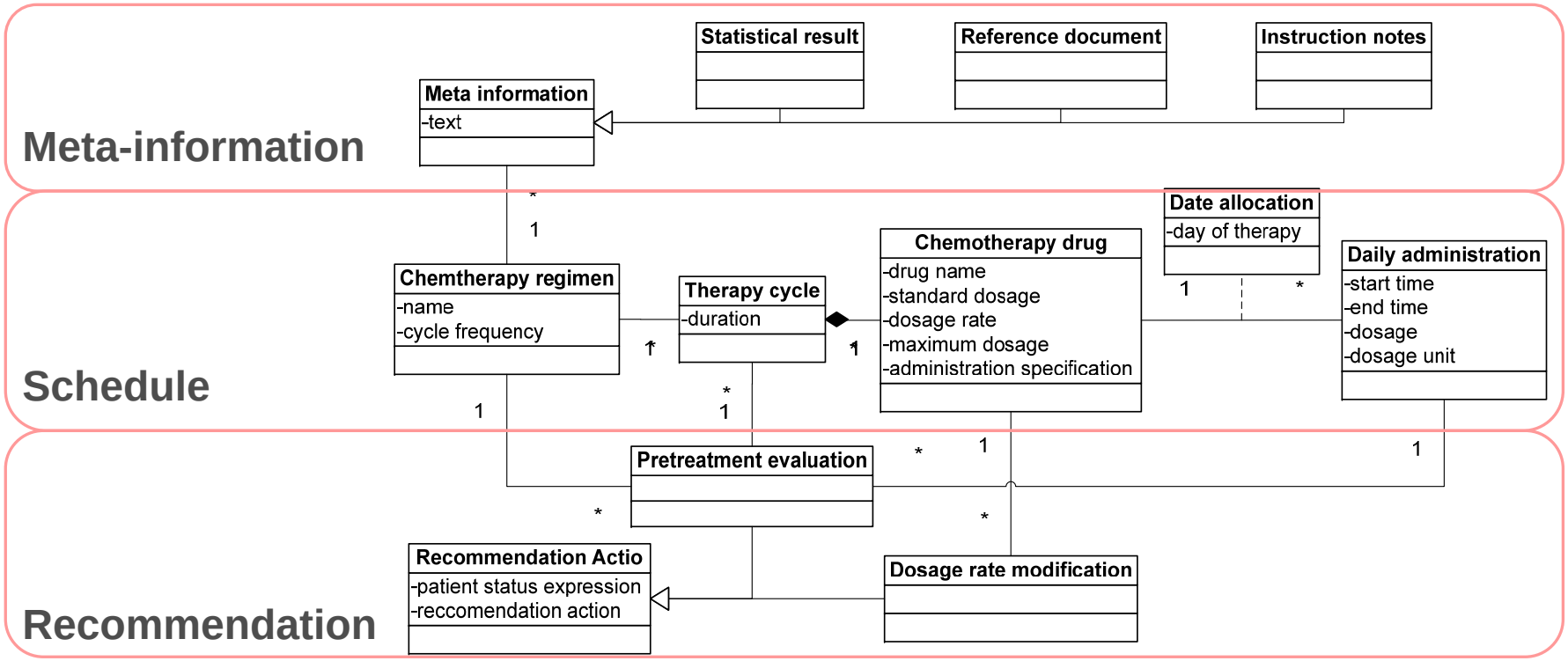
     Process model of chemotherapy work-flow.

  c. Heuristic knowledge to intervene in a chemotherapy planning.

     Model of expression language to represent decision criteria and therapy actions.

Results - a. Entity model

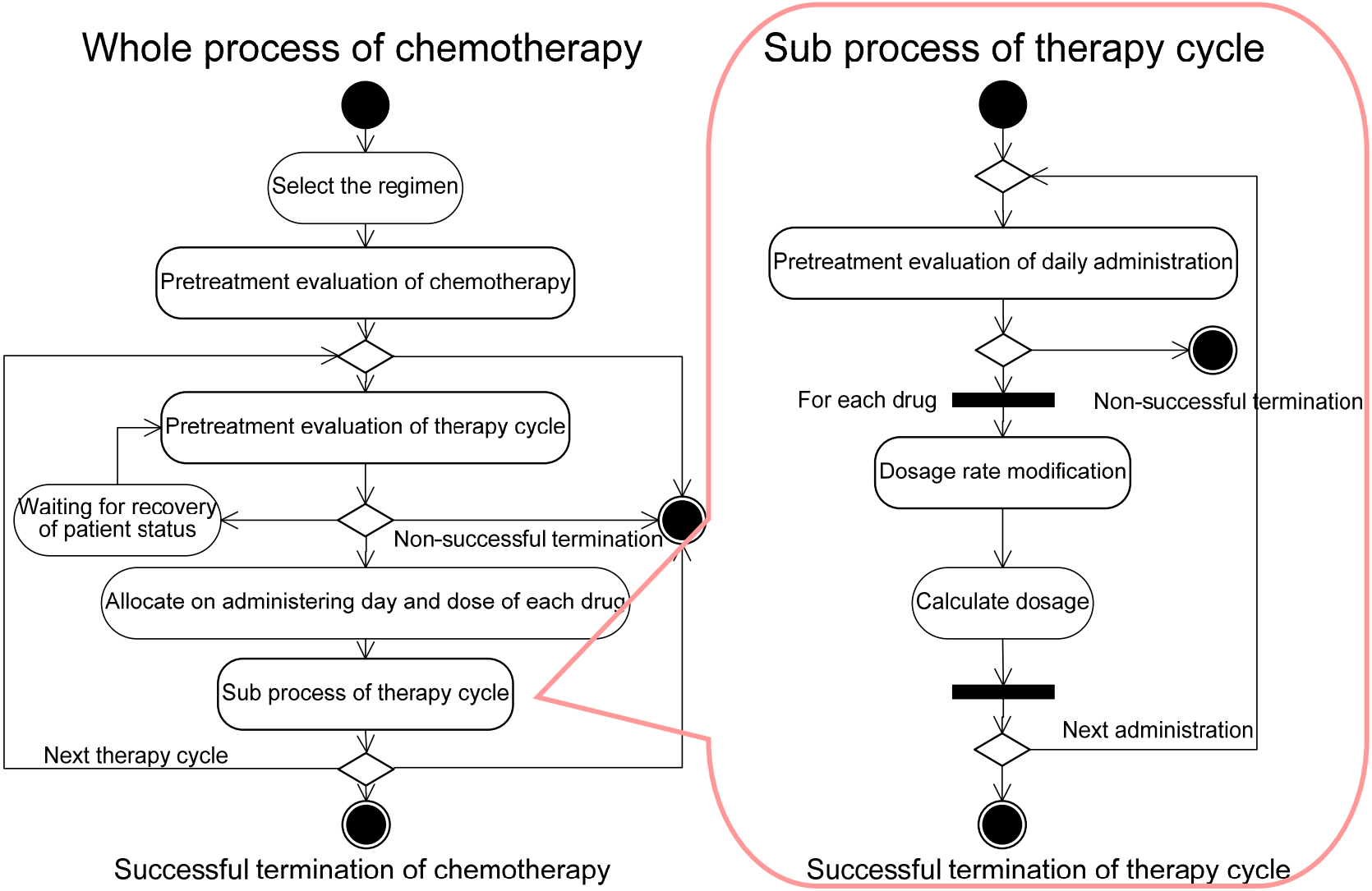
- Administration schedule of chemotherapy drug.
- Recommendation criteria of therapy actions.
- Meta-information about chemotherapy.



Results - b. Process model 1

- **Whole chemotherapy process consists of repetition of a therapy cycle.**
- **Therapy cycle consists of repetition of a daily administration.**
- **Four kinds of scenes of decision-making in those repetitions.**
  - Pretreatment evaluation of chemotherapy.
  - Pretreatment evaluation of therapy cycle.
  - Pretreatment evaluation of daily administration.
  - Dosage modification of chemotherapy drug.

Results - b. Process model 2



Results - c. Expression language

- **Recommendation criteria of therapy actions.**
  - Represented as a rule expression including classes of *Observation* and *Phenomenon*.
  - Expiration date of patient data has to be specified as *Time Context* for automated data retrieval.

Dosage Modification of Doxorubicin in CHOP

Time context: 14days

IF Phenomenon("Leukocytes_grade").greaterThan(3)

THEN Decrease Doxorubicin to 50% dose

Results - Knowledge base

- **Structured chemotherapy regimen.**
  - An Entity model and a model of expression language are combined.

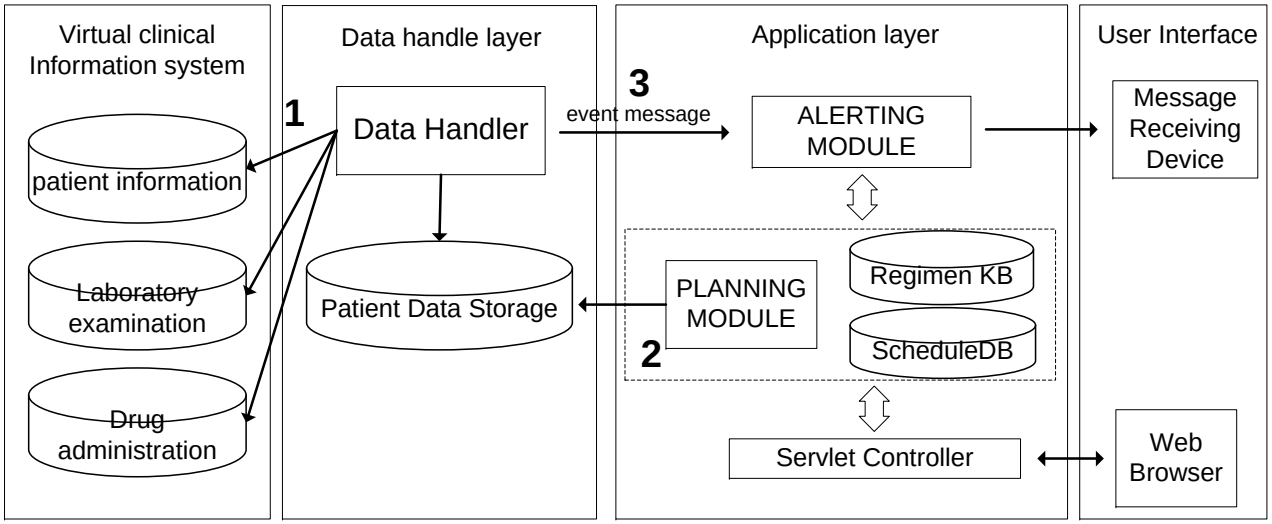
Example of a structured chemotherapy regimen of “CHOP”

```
<regimen name="CHOP" code="001" cycle_frequency="5">
  <therapy_cycle duration="21">
    <pretreatment_evaluation time_context=”14" unit=”day”>
      <lhs_expression> phenomenon(NCICTC_Leukocytes_Grade).greaterThan(3) </lhs_expression>
      <rhs_expression> Recommend beginning at the cycle to be postponed </rhs_expression>
    </pretreatment_evaluation>
    <chemotherapy_drug name="vincristine" standard_dosage="1.4" max_dosage=”2.0” dosage_unit=”mg”>
      <date_allocation> 1 </date_allocation>
      <administration_method route=”iv”>
        <division unit=”min”>60</division>
      </administration_method>
      <dosage_modification time_context=”14" unit=”day”>
        <lhs_expression> phenomenon (NCICTC_Leukocytes_Grade).greaterThan(2) </lhs_expression>
        <rhs_expression> Recommend reduce to 80% dose </rhs_expression>
  .........
```

Results - Prototype system

- **Two types of applications.**
  - **Planning module** provides a chemotherapy schedule while evaluating recommendation criteria.
  - **Alerting module** provides a notification message.

Overview of the prototype system architecture



1. Retrieve patient data from virtual clinical information system.
2. Reason about chemotherapy schedule according to the patient status.
3. Send an event message to alerting module.

Conclusion

- **We have presented the model of chemotherapy planning.**
  - Entity model of chemotherapy.
  - Process model of chemotherapy work-flow.
  - Model of expression language to represent the decision criteria and therapy action.
- **Through the implementation of the prototype system,**
  - Enables the system to support physicians appropriately in the chemotherapy work-flow.
  - Seems to be useful for preventing physicians from overlooking the information about patient.

Reference

[1] Tetsuichiro Muto. Regimens for Cancer Chemotherapy: Risk-based Management of Patients. Nankodo Co, Ltd, Tokyo, 2004.

[2] OMG. Unified Modeling Language Specification1.5, 2003. http:/www.omg.org/docs/formal/03-03-01.pdf