

The ManRay Project in Biomedical Informatics for Nuclear Medicine and Pharmacogenomic Molecular Imaging

Carl Taswell, Global TeleGenetics, Ladera Ranch, CA

Abstract

The ManRay Ontology for Nuclear Medicine has been updated for OWL 2 and incorporated with the ManRay Registry in the PORTAL-DOORS System (PDS) for management of resource metadata on the semantic web. Use of this ontology and registry will facilitate exchange of data for basic research or clinical trials involving nuclear medicine and pharmacogenomic molecular imaging for personalized medicine.

Objectives

To develop information resources, software tools and applications capable of supporting informatics research in nuclear medicine and pharmacogenomic molecular imaging (PGMI). Originally defined in (1) and discussed further in (2), PGMI involves a personalized medicine study that asks a pharmacological question in association with a genetic test and a molecular imaging procedure for an individual patient.

Methods

Initial development in 2005 of the ManRay ontology for nuclear medicine (3) was limited by the constraints of the semantic languages and interoperability frameworks available at the time. Since then, the language OWL has progressed to the enhanced version 2 recently approved as a W3C recommendation, and the PORTAL-DOORS System (PDS) has been developed as a new framework enabling both lexical and semantic search across different specialty domains (4,5). The current iteration of development for the ManRay project updates the ontology to exploit the new OWL 2 language and PDS framework. Ontologies for the ManRay project are constructed adhering to the specifications for XML, RDF, and the new OWL 2 as recommended by the W3C. General software engineering principles of hierarchical modularity, flexibility, and extensibility have been maintained as in the original version with a structure favoring composition of smaller ontologies, each of which has been updated for use with OWL 2 and PDS. Software development environments used include Altova XMLSpy, Stanford Protege, NeOn Project Toolkit and Microsoft Visual Studio with design influenced by modeling from the four perspectives of relational database, programmatic code, XML Schema, and OWL 2 objects.

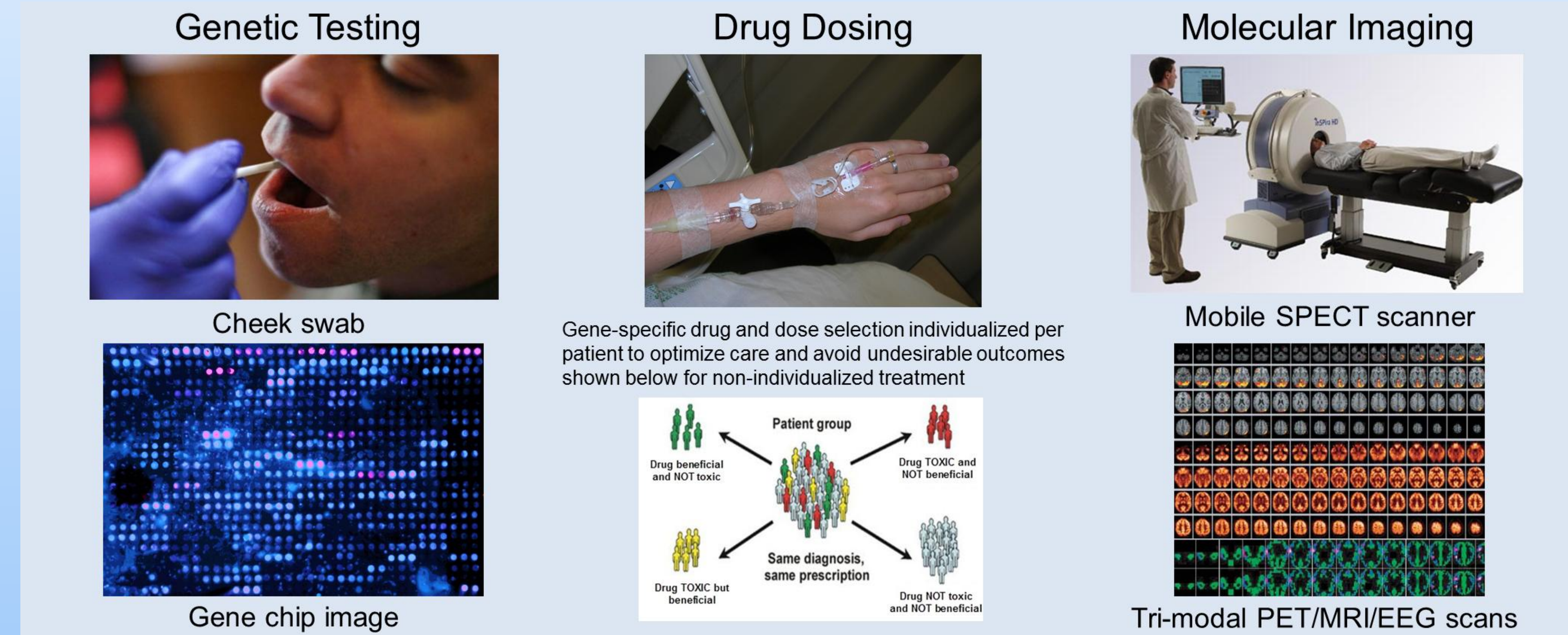


Fig 1: Genetic testing, drug dosing and molecular imaging comprise the essential steps of PGMI in personalized medicine; not shown are the data analyses necessary for gene-specific drug/dose selection and image biomarker monitoring.

ManRay Registry

PORTAL Status	DOORS Status	Type	Tag	Name	Nature
> Valid	Valid	Organization	AMI	Academy of Molecular Imaging	organization for physicians and other professionals in molecular imaging
> Valid	Valid	Organization	ARR	Academy of Radiology Research	organization for medical imaging research education and advocacy
> Valid	Valid	OnlineVirtualEntity	AIRO	Advance for Imaging & Radiation Oncology	website for medical imaging and radiation oncology news and information
> Valid	Valid	Organization	AGHDNM	Allegheny General Hospital Division of Nuclear Medicine	division of nuclear medicine at Allegheny General Hospital
> Valid	Valid	Organization	AAPM	American Association of Physicists in Medicine	professional group for physicists in medicine
> Valid	Valid	Organization	ABII	American Board of Imaging Informatics	organization for certification of professionals in imaging informatics
> Valid	Valid	Organization	ABNM	American Board of Nuclear Medicine	organization for certification of nuclear medicine physicians
> Valid	Valid	Organization	ABSNM	American Board of Science in Nuclear Medicine	organization for certification of nuclear medicine scientists
> Valid	Valid	Organization	ACMP	American College of Medical Physics	organization for medical physicists
> Valid	Valid	Organization	ACNM	American College of Nuclear Medicine	professional association for nuclear medicine

Fig 2: ManRay Registry records with resource metadata available for search in the PDS server networks.

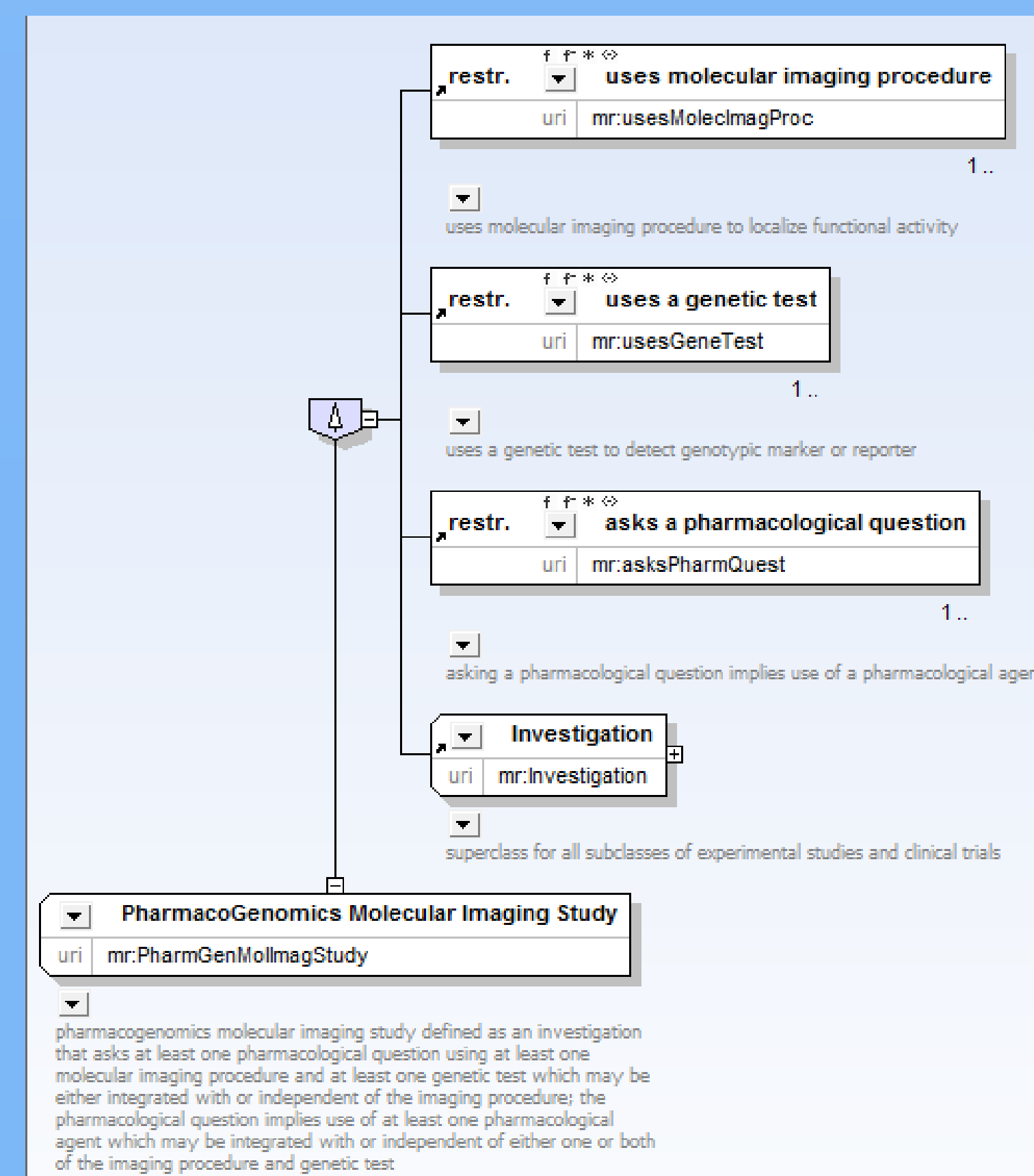


Fig 3: Diagram of essential concepts for a PGMI study.

```
<?xml version="1.0" encoding="utf-8" ?>
<PDS xmlns="http://pds.portaldoors.org/xmns/2006/npsysteme#">
  <!-- PORTAL-DOORS System (c) 2006-2010 Carl Taswell and Global TeleGenetics, Inc. -->
  <ServerResponse>
    <Status>OK</Status>
  </ServerResponse>
  <Answer>
    <NEXUS>
      <ResourceRepresentation>
        <EntityMetadata>
          <CanonicalLabel>http://pds.nucmedlib.net/manray/mgibrge/CanonicalLabel</CanonicalLabel>
          <AliasLabels>
            <AliasLabel>http://pds.nucmedlib.net/manray/v4bf05089/AliasLabel</AliasLabel>
          </AliasLabels>
          <PrincipalTag>MGIBRGE</PrincipalTag>
          <SupportingLabels>
            <SupportingLabel>http://pds.portaldoors.net/mesh2010/molecular_imaging/SupportingLabel</SupportingLabel>
          </SupportingLabels>
          <CrossReferences>
            <CrossReference>http://jnm.snmjournals.org/cgi/content/abstract/49/Suppl_2/1645</CrossReference>
            <CrossReference>http://dx.doi.org/10.2967/jnumed.107.045955</CrossReference>
            <CrossReference>http://www.ncbi.nlm.nih.gov/pubmed/18523072</CrossReference>
          </CrossReferences>
          <Locations>
            <Location>
              <LocationURI>http://jnm.snmjournals.org/cgi/reprint/49/Suppl_2/1645</LocationURI>
              <DisplayText>JNM reprint</DisplayText>
            </Location>
          </Locations>
          <Name>Molecular-Genetic Imaging Based on Reporter Gene Expression</Name>
          <Nature>article by Kang and Chung in Journal of Nuclear Medicine</Nature>
        </EntityMetadata>
        <RecordMetadata>
          <CreatedOn>2010-10-18T04:51:48Z</CreatedOn>
          <UpdatedOn>2010-10-18T05:07:35Z</UpdatedOn>
          <Registrar>http://pds.telegenetics.net/gtg-nexus</Registrar>
          <Registry>http://pds.nucmedlib.net/manray</Registry>
          <Directory>http://pds.telegenetics.net/gtg-doors</Directory>
        </RecordMetadata>
        <ResourceRepresentation>
          <NEXUS>
            <Answer>
              <ServerResponse>
                <PDS>

```

Fig 4: Example metadata record from ManRay Registry/Ontology.

Results

The ManRay project implements an ontology and registry for nuclear medicine, radiopharmaceuticals, and molecular imaging. The ontology is structured as a hierarchy of *.owl files with manray.owl as the top level and separate *.owl files for imaging protocols, pharmaceuticals, and radionuclides as the lower levels. It has now been enhanced to incorporate the new features of OWL 2, modified for compliance with the interoperability requirements of PDS, and extended to address more explicitly the concepts of pharmacogenomic molecular imaging (1,2). The website www.portaldoors.org hosts ManRay and the other PDS prototype registries (including BrainWatch, GeneScene, and Beacon) together with their schemas and ontologies. Software with Microsoft ASP.Net and SQL code together with the most up-to-date XML schemas and OWL ontologies are available for download. Additional information specific to the ManRay Project is available at www.nucmedlib.net.

Conclusions

Development of an ontology as an open standard for the exchange of data involving nuclear medicine, radiopharmaceuticals and molecular imaging together with an associated registry of resources constitutes the most important goal of the ManRay Project. Such a combination of ontology and registry serves as a necessary component of a framework in support of a knowledge engineering workbench for basic research or clinical trials involving pharmacogenomic molecular imaging.

References

1. Taswell C. PORTAL-DOORS Infrastructure System for Translational Biomedical Informatics on the Semantic Web and Grid. Proc 2008 AMIA STB, San Francisco, USA; AMIA-043-T2008.
2. Taswell C. Knowledge Engineering for Pharmacogenomic Molecular Imaging of the Brain. Proc 2009 IEEE Intl Conf Semantics Knowledge and Grid, Zhuhai China; pp. 26-33.
3. Taswell C et al. The ManRay Project: Initial Development of a Web-Enabled Ontology for Nuclear Medicine. Proc 2006 SNM Annual Meeting, San Diego, USA; p1431.
4. Taswell C. DOORS to the semantic web and grid with a PORTAL for biomedical computing. 2008 IEEE Trans Inf Technol Biomed 12(2):191 in Special Section on Bio-Grid (DOI: 10.1109/TITB.2007.905861).
5. Taswell C. A Distributed Infrastructure for Metadata about Metadata: The HDMM Architectural Style and PORTAL-DOORS System. 2010 Future Internet 2(2):156-189 (DOI: 10.3390/FI2020156).