**Gender Mismatch Detection System - Standard Implementation**

**System Overview**

This system provides automated detection of gender mismatches in radiology reports through multiple implementation approaches:

**Implementation Phases**

1. **Standard Implementation** (Current Focus) - Pre-defined keyword-based detection
2. **Custom Keyword Management** (Phase 2) - Radiologist-configurable keyword lists
3. **Natural Language Criteria** (Phase 3) - AI-powered flexible detection rules

**Standard Implementation - Keyword Library**

**Core Business Rules**

**Gender Metadata Processing**

* **Supported Types**: Male, Female, Unknown
* **Unknown Gender**: Skip all processing
* **Missing Gender**: Extract from report text, if unsuccessful → skip processing

**Age-Based Detection Logic**

**Female Patients (All Ages)**

* Flag ALL male-specific body parts
* Flag ALL male-specific findings
* No age restrictions

**Male Patients ≥8 Years**

* Flag ALL female-specific body parts
* Flag ALL female-specific findings
* Flag ALL pregnancy-related terms
* **Exception**: Fetal position/delivery terms (NOT flagged)

**Male Patients <8 Years**

* Flag non-pregnancy female body parts only
* Flag non-pregnancy female findings only
* **Do NOT flag**: Any pregnancy-related terms

**Standard Keyword Categories**

**Male-Specific Body Parts**

prostate

prostatic

testis

testes

testicular

testicle

testicles

scrotum

scrotal

penis

penile

glans

prepuce

foreskin

epididymis

epididymal

vas deferens

seminal vesicle

seminal vesicles

spermatic cord

**Male-Specific Clinical Findings (Keywords)**

BPH

prostatitis

cryptorchidism

hydrocele

varicocele

epididymitis

orchitis

priapism

gynecomastia

**Male-Specific Lab Tests**

PSA

prostate specific antigen

prostate-specific antigen

free PSA

PSA ratio

semen analysis

sperm count

sperm concentration

sperm motility

sperm morphology

**Female-Specific Body Parts**

**Non-Pregnancy Related:**

uterus

uterine

ovary

ovaries

ovarian

fallopian tube

fallopian tubes

cervix

cervical

vagina

vaginal

vulva

vulvar

labia

clitoris

endometrium

endometrial

myometrium

myometrial

adnexa

adnexal

**Pregnancy-Related:**

placenta

placental

amniotic

umbilical cord

fetal

fetus

**Female-Specific Clinical Findings (Keywords)**

**Non-Pregnancy Related:**

PCOS

endometriosis

adenomyosis

PID (Pelvic Inflammatory Disease)

vaginismus

vulvodynia

**Pregnancy-Related:**

pregnant

pregnancy

gravid

gravida

gestation

gestational

trimester

prenatal

antenatal

obstetric

obstetrical

conception

fertilization

implantation

menstrual

menstruation

menopause

menopausal

ovulation

gynecologic

gynecological

preeclampsia

eclampsia

miscarriage

abortion

IUGR

oligohydramnios

polyhydramnios

**Female-Specific Lab Tests**

**Non-Pregnancy Related:**

pap smear

pap test

cervical cytology

HPV test

mammography

mammogram

**Pregnancy-Related:**

beta-hCG

beta hCG

human chorionic gonadotropin

hCG

AFP

alpha-fetoprotein

PAPP-A

pregnancy-associated plasma protein

triple screen

quad screen

first trimester screen

second trimester screen

glucose tolerance test

GCT

OGTT

group B strep

GBS culture

**Exception Keywords (Male <8: NOT Flagged)**

breech

vertex

forceps

cesarean

c-section

episiotomy

**Patient Reference Keywords**

female

male

she

her

hers

he

him

his

woman

man

girl

boy

**Exclusion Rules**

**Healthcare Provider Context (NO MISMATCH)**

**Trigger Words Before Gender Reference:**

physician

doctor

dr

nurse

provider

technician

radiologist

clinician

staff

attending

resident

intern

**Communication Context (NO MISMATCH)**

**Communication Verbs + Patient/Family:**

spoke

talked

discussed

communicated

contacted

called

informed

told

asked

explained

consulted

**Implementation Logic**

**Processing Workflow**

1. Check gender metadata → Unknown? Skip processing

2. Extract patient age

3. Apply keyword matching:

- Female: Search for male keywords (body parts + findings + lab tests)

- Male ≥8: Search for female keywords (with exceptions)

- Male <8: Search for non-pregnancy female keywords only

4. Apply exclusion rules to patient references

5. Generate alerts for matches

**Regular Expression Patterns**

**Male-Specific Pattern**

\b(prostate|prostatic|testis|testes|testicular|testicle|testicles|scrotum|scrotal|penis|penile|glans|prepuce|foreskin|epididymis|epididymal|vas\s+deferens|seminal\s+vesicle|seminal\s+vesicles|spermatic\s+cord|BPH|prostatitis|cryptorchidism|hydrocele|varicocele|epididymitis|orchitis|priapism|gynecomastia|PSA|prostate\s+specific\s+antigen|prostate-specific\s+antigen|free\s+PSA|PSA\s+ratio|semen\s+analysis|sperm\s+count|sperm\s+concentration|sperm\s+motility|sperm\s+morphology)\b

**Female Non-Pregnancy Pattern**

\b(uterus|uterine|ovary|ovaries|ovarian|fallopian\s+tube|fallopian\s+tubes|cervix|cervical|vagina|vaginal|vulva|vulvar|labia|clitoris|endometrium|endometrial|myometrium|myometrial|adnexa|adnexal|PCOS|endometriosis|adenomyosis|PID|vaginismus|vulvodynia|pap\s+smear|pap\s+test|cervical\s+cytology|HPV\s+test|mammography|mammogram)\b

**Female Pregnancy Pattern**

\b(placenta|placental|amniotic|umbilical\s+cord|fetal|fetus|pregnant|pregnancy|gravid|gravida|gestation|gestational|trimester|prenatal|antenatal|obstetric|obstetrical|conception|fertilization|implantation|menstrual|menstruation|menopause|menopausal|ovulation|gynecologic|gynecological|preeclampsia|eclampsia|miscarriage|abortion|IUGR|oligohydramnios|polyhydramnios|beta-hCG|beta\s+hCG|human\s+chorionic\s+gonadotropin|hCG|AFP|alpha-fetoprotein|PAPP-A|pregnancy-associated\s+plasma\s+protein|triple\s+screen|quad\s+screen|first\s+trimester\s+screen|second\s+trimester\s+screen|glucose\s+tolerance\s+test|GCT|OGTT|group\s+B\s+strep|GBS\s+culture)\b

**Exception Pattern (Male <8)**

\b(breech|vertex|forceps|cesarean|c-section|episiotomy)\b

**Healthcare Provider Exclusion**

(?:physician|doctor|dr\.?|nurse|provider|technician|radiologist|clinician|staff|attending|resident|intern)\s+.{0,50}\b(he|she|his|her|him|male|female)\b

**Communication Exclusion**

(?:spoke|talked|discussed|communicated|contacted|called|informed|told|asked|explained|consulted)\s+(?:with\s+)?(?:the\s+)?(?:patient|family|mother|father|parent|guardian)\s+.{0,50}\b(he|she|his|her|him|male|female)\b

**Alert Priority Levels**

**High Priority (Immediate Review)**

1. Female patient + male body parts/findings/lab tests
2. Male ≥8 + female body parts/findings/lab tests
3. Male ≥8 + pregnancy findings/lab tests (except delivery terms)
4. Male <8 + non-pregnancy female body parts/findings/lab tests

**Medium Priority (Standard Review)**

1. Patient reference mismatches (after exclusions applied)

**No Alert**

1. Unknown gender patients
2. Healthcare provider context matches
3. Communication context matches
4. Male <8 + pregnancy-related matches
5. Male <8 + delivery exception matches

**Future Implementation Phases**

**Phase 2: Custom Keyword Management**

* Radiologist interface to add/remove keywords
* Institution-specific keyword libraries
* Keyword confidence scoring
* Usage analytics and optimization

**Phase 3: Natural Language Criteria**

* AI-powered semantic understanding
* Flexible rule creation in natural language
* Context-aware pattern recognition
* Advanced clinical reasoning

**Technical Integration**

**Database Schema**

-- Standard keyword tables

gender\_keywords (

id,

keyword,

gender\_type,

category,

subcategory,

pregnancy\_related,

enabled

)

gender\_exclusions (

id,

pattern,

context\_type,

enabled

)

gender\_rules (

id,

rule\_name,

age\_threshold,

enabled

)

**API Structure**

POST /api/gender-mismatch/detect

{

"report\_text": "string",

"patient\_gender": "Male|Female|Unknown",

"patient\_age": number

}

Response:

{

"mismatches": [

{

"keyword": "string",

"category": "string",

"priority": "High|Medium",

"context": "string"

}

],

"processing\_skipped": boolean,

"skip\_reason": "string"

}

**Configuration Options**

* Enable/disable standard implementation
* Set age threshold (default: 8 years)
* Configure alert priority levels
* Adjust exclusion rule sensitivity
* Integration with existing workflows

**Quality Assurance**

**Validation Approach**

1. A / B testing of keyword search vs AI LLM
   1. Confusion matrix on agrees vs disagree.
   2. #Alerts per report (to determine alert fatigue)
   3. Disagree (keyword search alerts but LLM misses) - Consistency of Keyword search against LLM Misses
   4. Disagree (LLM alerts but Keyword misses) - Missed knowledge of LLM against Keyword search.

**Performance Metrics**

* Processing time per report
* Keyword match distribution
* Alert resolution time (proxy is #alerts per report)

This standard implementation provides the foundation for automated gender mismatch detection while maintaining extensibility for future customization and AI-powered enhancements.