



# "Single Institution **Digital Pathology** Implementation Experience and Future Visions"



Flodr P, MD, PhD  
DCMP FMD and FH Olomouc  
Czech Republic





## Conflict of interest statement

Roche Diagnostics, Roche Molecular Systems, Santa Clara, CA



# Digital Pathology

## Evolution to digital pathology

**Increasing amount of professional tasks** in current medicine is a challenge for a building up **time saving and more precise workflow** with a broad access to medical informations (clinics, labs, imaging) in tumor boards with subsequent record with experts' decisions and conclusions





# Digital Pathology

## Evolution to digital pathology

### Digitization

Convert something into a digital format into bits and bytes (binary arithmetic, Gottfried Leibniz 1679)





# Digital Pathology

Evolution to digital pathology

## Digitization

What can be converted into digital signal

Image

Picture

Document

Sound



# Digital Pathology

Evolution to digital pathology

## Digitalization

Converts working process due to the advanced digital technologies





# Digital Pathology

## Evolution to digital pathology

### Digitalization

Replaces analogue or offline system (paper, whiteboards, backwards projector, light microscopes)

Allows progress of working model that provide value-producing opportunities

Expands new medicine horizons in multidisciplinary communication including relevant medical decisions





# Digital Pathology

## Evolution to digital pathology

### Digitization, digitalization and digital transformation of pathology

Digitization	fixing the past
Digitalization	focusing on the present
Digital transformation	creating the future



# Digital Pathology

## Evolution to digital pathology

### Digitization, digitalization and digital transformation of pathology

Standardization

Modularization

Customization

Flexibility

Efficiency

Interoperability





# Digital Pathology

## Evolution to digital pathology

### Digitization, digitalization and digital transformation of pathology

Current medical informations reside in **disparate or isolated hospital databases or source systems** (electronic medical records, laboratory information systems, picture archiving and communication system - PACS)





# Digital Pathology

Evolution to digital pathology

**Digitization, digitalization and digital transformation of pathology**

**Requirements**



# Pathology Lab Digital Transformation

Requirements	Instrumental	Human	Consumables
Basic	Barcoding, slide scanning, high resolution displays, ergonomic workstation, efficient servers, storage and networking	Training and cognisance of digitalised processing, digital image diagnostic confidence, diagnostic algorithms, on-site and remote reporting choice	Compatible barcoding stickers, slides for scanner racks, standard staining procedures
Advanced	Specimen and diagnosis based automated processing, IF scanning	Personalisation of offered digitalised processes, computational aided image analysis, usage of third party applications	Specimen volume adapted automated processing, laser engraver barcoding
Future	AI virtual slides viewing and diagnostic screening, multiplex and 3D imaging	Bioinformatics and statistics diagnostic analysis, case clustering and review reporting, augmented reality usage	Fully automated and standardised gross specimen processing with 3D construct, hologram barcoding



# Digital Pathology

Evolution to digital pathology

**Digitization, digitalization and digital transformation of pathology**

**Current appeal**





5688/24  
5688/24 B  
5688/24 C  
5688/24 D  
5688/24 E  
5688/24 F  
5688/24 G  
5688/24 H

H5688/24 A He  
H5688/24 B He  
H5688/24 C He  
H5688/24 D He  
H5688/24 E He  
H5688/24 F He  
H5688/24 G He

Analog workload accumulation(s) and consequent downtime in case(s) viewing and reporting

## Hybrid, semi-digitalized pathology workflow

PRŮVODKA ELEKTRONICKÉ ŽÁDANKY

Dokument č.: Fm-L009-035-LAB-001  
Verze č.: 1

ID: [redacted] M Plátce: 111  
Jméno: [redacted] Diagnózy: D120

Oddělení: 1.CH-LU3 Telefon: 2456  
IČP: 89301041 Odb.: 5F1 VS: 0413 Lékař: [redacted]  
IČL: [redacted]

11.03.24 12:12  
Plánovaný datum a čas Datum a čas příjmu  
Vitální indikace Statim

Č. vzorku: 11447548

Biologický materiál: **Biopsie**  
Odběrový materiál: **biopsie**  
Biopsie PAT

**Informace pro laboratoř:**  
Tumor - polyp cévka resekce - prepravý tračnik s tumorem

**BLOKOVÁNÍ ASISTUJE** *ob. Fd. KF*

Celkový počet vzorků: 1 Razítko pracoviště:

*stuno (R) 131a  
5688/A-M  
appendix (R) 131a  
5689/A-G  
(R) 131a sub. R. na dopřít  
5689/A →*

Přijem: 11.03.24 13:02  
Příj: [redacted]  
[redacted]  
H 5688-5670 04907 / 24



Missing informations



Multiple confusing barcodes  
(with low informational density)



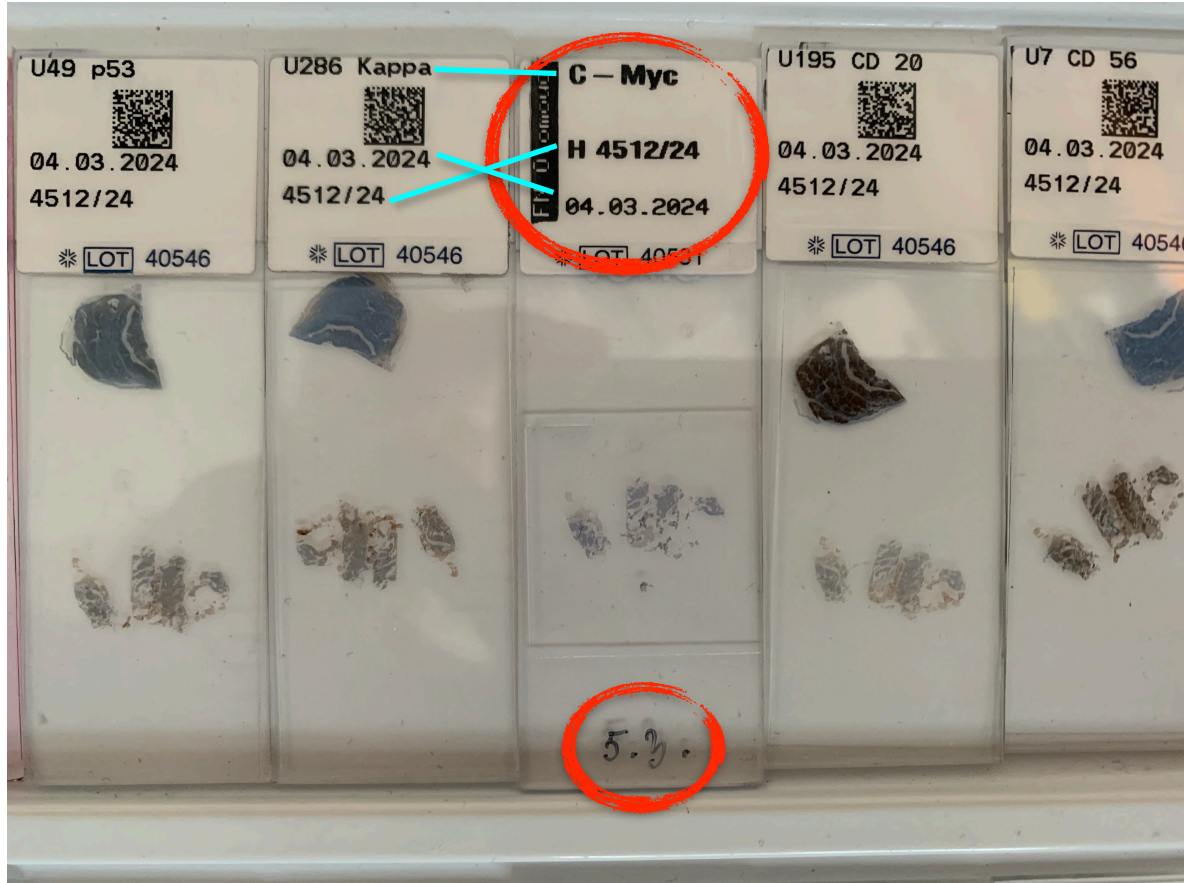
Additional stamps and hand written  
notes



Hand written  
specimen origin, alphanumerical  
sorting of blocks, cassettes and slides,  
gross archiving note, account coding,  
additional specimen processing note



## Hybrid, semi-digitalized pathology workflow



Missing barcoding  
(more inf. dense QR code)

Haphazard localisation  
and different format  
and font of printed text

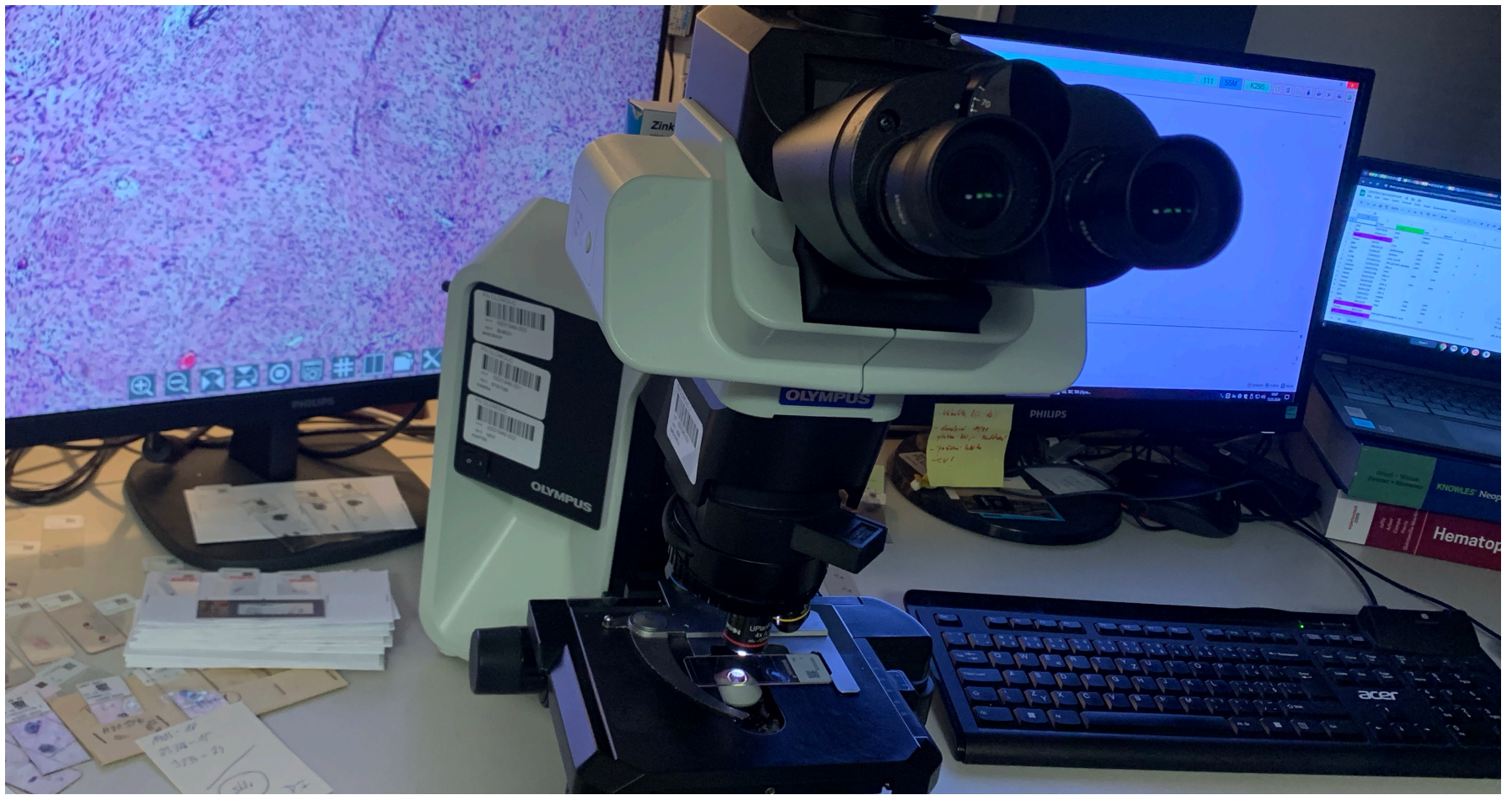
Differently printed  
and hand written additional  
date



## Hybrid, semi-digitalized pathology workflow

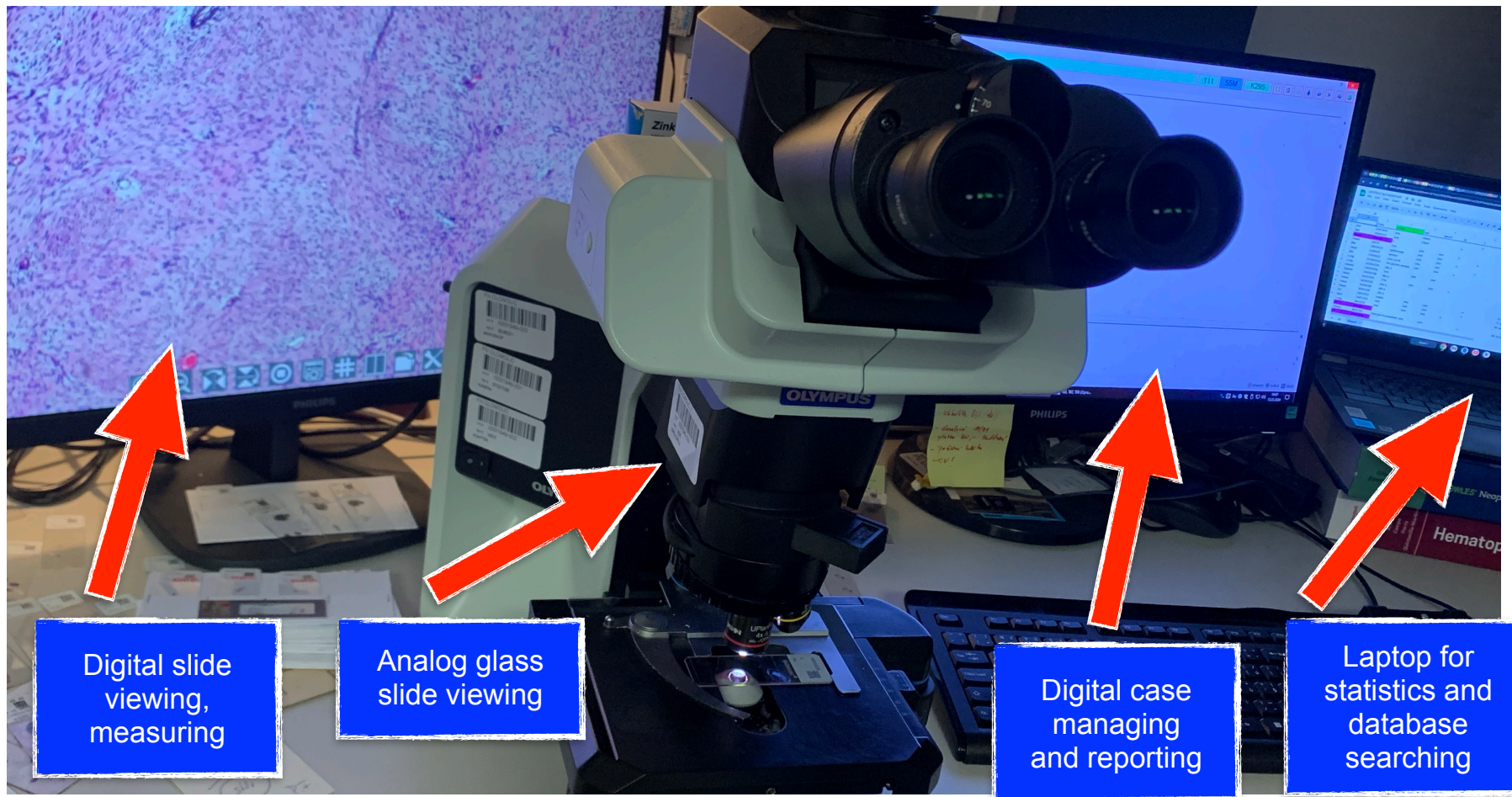


Missing barcoding, hand written signature, question mark, red dot, partly lost text of applied method, additional handwritten text on a paper



Hybrid, semi-digitalized pathology workstation





Hybrid, semi-digitalised pathology workstation





# Pathology Lab Digital Transformation

Field of possible advantage	Field of possible disadvantage
Swift slide reading, computer-aided slide reading, WSI	Network interruption
Swift case managing	Failure of digital storage
Swift slide storage, searching in and retrieval from storage	External cassette and slide barcode
Speeding up of case turnover	Internal barcoding failure (stickers)
Easy case presenting	Glass slide, covering slip, specimen cut irregularities, specimen out of covering slip
Easy additional methods ordering	Scanning fault (glass slide sticking, breaking or dropping, barcode reading failure, focusing error, downtime duration)
Home office diagnostic reporting	Workstation's displays
Tracing case processes	Slide reading irregularities
Additional platform(s) application	
Statistics and bioinformatics	



# Pathology Lab Digital Transformation

Field of possible advantage	Field of possible disadvantage
Swift slide reading, computer-aided slide reading	Network interruption
Swift case managing	Failure of digital storage
Swift slide storage and searching in storage	External cassette and slide barcode collision
Speeding up of case turnover	Internal barcoding failure (stickers)
Case presenting	Glass slide, covering slip, specimen cut irregularities, specimen out of covering slip
Additional methods ordering	Scanning fault (glass slide sticking, breaking or dropping, barcode reading failure, focusing error, downtime duration)
Home office diagnostic reporting	Workstation displays resolution
Tracing case processes	Slide reading irregularities
Additional platform(s) application	
Statistics and bioinformatics	



# Digital Pathology

## Evolution to digital pathology

**Digitization, digitalization and digital transformation of pathology**

**Multidisciplinary tumour board applications**

**Navify@ - NTBS Roche modular, integrative bridge across databases,  
multidisciplinary access**

**Immediate technological challenge**



Electronic Medical Records

Diagnostics (LIS)

Molecular data

Imaging (PACS)

Clinical trials

Publications

Digital pathology

## NAVIFY Portfolio



# NAVIFY® Portfolio

Electronic Medical Records



Diagnostics (LIS)



Molecular data

Imaging (PACS)

Clinical trials

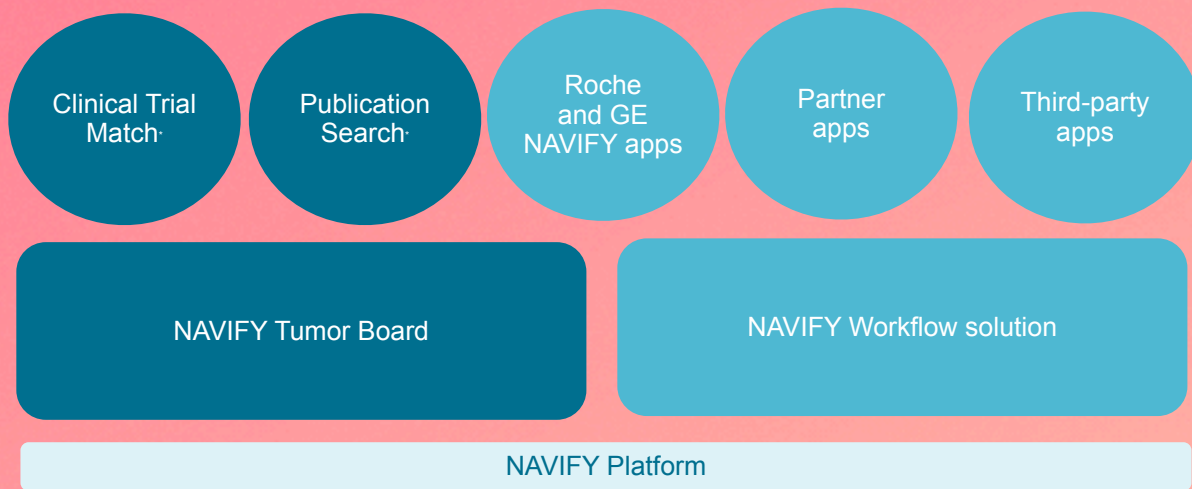
Publications



Digital pathology

**NAVIFY  
Portfolio**











## TUMOR BOARDS

[CREATE NEW](#)

All tumor boards

## Lung

30 May 2019, 08:00am - 09:00am

## Multidisciplinary

29 May 2019, 08:00am - 09:00am

Location: DaVinci Conference Room

Video call: [Join meeting](#)

Attendees: Dr. Pan, Dr. Ulrich, Dr. Reis, Dr. Dressel, Dr. Evans

## Past events

## Multidisciplinary

30 Apr 2019, 08:00am - 09:00am

## Breast

29 Apr 2019, 08:00am - 09:00am

## Lung

28 Apr 2019, 10:00am - 11:00am

## GI

27 Apr 2019, 09:00am - 10:00am

## Multidisciplinary

26 Apr 2019, 08:00am - 09:00am

## Breast

25 Apr 2019, 08:00am - 09:00am

## 8 PATIENTS

[ADD PATIENT](#) [PRINT LIST](#) [EDIT PRESENTATION](#) [VIEW PRESENTATION](#)

ORDER	NAME	POINT OF DISCUSSION	ATTACHMENTS	REQUESTED BY
1	<b>Kren, Jane</b> Female, 44 MRN 849506933	<b>Post surgery review</b> Patient does not want bilateral mastectomy wants localized surgery. What is the post-op plan?	8	Dr. Ana Smith
2	<b>Clarke, Sofia</b> Female, 88 MRN 831331PEQ	<b>Follow up</b> Patient presents with severe hypercalcemia and diffuse lymphadenopathy. History of worsening pancytopenia and peripheral smear with myelodysplastic changes.	5	Dr. Barbara Chang
3	<b>Schmidt, Jennifer</b> Female, 52 MRN 20188675309	<b>Treatment</b> Determine best path given biomarkers and staging to date.	14	Dr. Ana Smith
4	<b>Lopez, Patricia</b> Female, 34 MRN 849506933	<b>Relapse</b> Ductal carcinoma in-situ, nuclear grade 2, greatest extent of DCIS at least 11mm, margins negative (closest superior soft tissue at 8mm), changes consistent with treatment effect, 1/2 lymph nodes positive.	none	Dr. Barbara Chang
5	<b>M, Roger</b> Male, 80 MRN 542181202	<b>Treatment response</b> no additional notes	8	Dr. Ana Smith
6	<b>Smith, Margareth</b> Female, 41 MRN 411346OPS	<b>Follow up</b> History of worsening pancytopenia and peripheral smear with myelodysplastic changes. Patient presents with severe hypercalcemia and diffuse lymphadenopathy.	5	Dr. Barbara Chang
7	<b>Silva, Zelia</b> Female, 55 MRN 849506V013	<b>Treatment response</b> no additional notes	none	Dr. Barbara Chang



Kren, Jane

Female, 44  
MRN 849506933

[SUBMIT TO TUMOR BOARD](#)

**CANCER INFO**

Right breast  
Invasive Ductal Carcinoma NOS

c T2 N1 M0 Stage IIB

p T2 N1a M0 Stage IIB

**PATIENT HISTORY**

**APPS**



Clinical Trial Match



Publication Search

**CANCER INFO**

[EDIT](#)

**SUMMARY**

44-year-old post-menopausal woman who initially presented to her gynecologist in Nov 2018 with a right breast lump. Mammogram (4th Dec 2018) showed an irregular spiculated 25mm mass in the right upper outer quadrant. Core Needle Biopsy (10th Dec 2018) revealed a well differentiated (grade 1) invasive ductal carcinoma. Biomarkers show ER positive; PR positive; HER2 negative.

**STAGE**

c T2 N1 M0 Stage IIB

p T2 N1a M0 Stage IIB

**BIOMARKERS**

TYPE	VALUE	STATUS
ER	0	Positive
PR	0	Positive
HER2	1	Negative

**GENOMICS**

ALTERATIONS	VAF	APPROVED THERAPIES	THERAPIES IN OTHER TUMOR TYPE
PIK3CA H1047R	18%	None	Everolimus Temsirrolimus <a href="#">show more</a>
CCND1 amplification	13%	None	None <a href="#">show more</a>
CDH1 E167*	16%	None	None <a href="#">show more</a>

**TREATMENT HISTORY**

START DATE	END DATE	THERAPEUTICS	DESCRIPTION	RESPONSIBLE
10 Dec 2018	10 Dec 2018	Right breast needle core biopsy	Invasive Ductal Carcinoma, well differentiated grade 1	Dr. Richard Johnson

**TUMOR INFORMATION**

**TYPE** Invasive Ductal Carcinoma NOS  
**LOCATION** Right breast  
Upper outer quadrant  
**OTHER** Size 25 mm

**TIMELINE**

[ADD TIMELINE ITEM](#)

All events

**Upcoming Events**

**Multidisciplinary**  
29 May 2019  
Point of Discussion: Post surgery review and post...  
Dr. A. Smith

**Past Events**

**Molecular Profile report** PDF  
01 May 2019  
Patient confirmed with BRCA2 mutation  
Dr. J. Lee

**Radiation therapy**  
07 Apr 2019  
Radiation to the chest wall and right axilla  
Dr. R. Stan

**Chemotherapy**  
05 Mar 2019  
A = Doxorubicin Hydrochloride (Adriamycin) C=Cy...  
Dr. R. Stan

**2018**

**MRI**  
29 Dec 2018  
After gadolinium administration, den...  
Dr. R. Spencer

**Radiology report** PDF  
29 Dec 2018  
Report shows heterogeneous mass  
Dr. R. Spencer

**Breast tumor board**  
21 Dec 2018  
Point of Discussion: New Patient  
Dr. A. Smith



Kren, Jane

Female, 44  
MRN 849506933

SUBMIT TO TUMOR BOARD

## CANCER INFO

Right breast  
Invasive Ductal Carcinoma NOS

c	T2	N1	M0	Stage IIB
p	T2	N1a	M0	Stage IIB

## PATIENT HISTORY

## APPS



## Molecular Profile report ①

EDIT

01 May 2019

Patient confirmed with BRCA2 mutation and opted to postpone bilateral mastectomy



Patient Name	Report Date	Diagnosis
Kren, Jane	May 2019	Invasive Ductal Carcinoma

Date of Birth	1950-01-01	Client Physician	City Hospital Smith, Susan	Specimen Received	May 2012
Gender	Female	Additional Recipient	Lee, Laura	Specimen Site	Breast
FMI Case #	Sample	FMI Client #	Sample	Specimen Date	August 2011
Medical Record #	Sample	Pathologist	Allen, Alison	Specimen Type	Block
Block ID	Sample				

## ABOUT THE TEST:

FoundationOne™ is a next-generation sequencing (NGS) based assay which identifies genomic alterations within hundreds of cancer-related genes.

## PATIENT RESULTS

3 genomic alterations [pg - 2](#)2 therapies associated with potential clinical benefit [pg - 3](#)0 therapies associated with lack of response [pg - 3](#)5 clinical trials [pg - 4](#)

## TUMOR TYPE: BREAST CARCINOMA

## Genomic Alterations Identified

PIK3CA H1047R  
CCND1 amplification  
CDH1 E167

## THERAPEUTIC IMPLICATIONS

Genomic Alterations Detected	FDA Approved Therapies (in patient's tumor type)	FDA Approved Therapies (in another tumor type)	Potential Clinical Trials
------------------------------	--	--	---------------------------

PIK3CA H1047R	None	Everolimus Temsirolimus	Yes, see clinical trials section
---------------	------	----------------------------	----------------------------------

## SUPPORTING ATTACHMENTS

SELECT MULTIPLE 

## TIMELINE

ADD TIMELINE ITEM

All events

## Upcoming Events

**Multidisciplinary**  
29 May 2019  
Point of Discussion: Post surgery review and post...  
Dr. A. Smith

## Past Events

**Molecular Profile report** [PDF](#)  
01 May 2019  
Patient confirmed with BRCA2 mutation  
Dr. J. Lee

**Radiation therapy**  
07 Apr 2019  
Radiation to the chest wall and right axilla  
Dr. R. Stan

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05 Mar 2019  
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Dr. R. Stan

2018

**MRI**  
29 Dec 2018  
After gadolinium administration, den...  
Dr. R. Spencer

**Radiology report** [PDF](#)  
29 Dec 2018  
Report shows heterogeneous mass  
Dr. R. Spencer

**Breast tumor board**  
21 Dec 2018  
Point of Discussion: New Patient  
Dr. A. Smith

Kren, Jane

Female, 44  
MRN 849506933[SUBMIT TO TUMOR BOARD](#)

## CANCER INFO

Right breast  
Invasive Ductal Carcinoma NOS

c	T2	N1	M0	Stage IIB
p	T2	N1a	M0	Stage IIB

## PATIENT HISTORY

## APPS

Clinical Trial  
MatchPublication  
Search

## MRI

29 Dec 2018

After gadolinium administration, dense breasts with marked enhancement were identified. The T2 weighted images showed an 2.5 cm area of decreased attenuation with spiculated borders and peripheral rim enhancement, in the upper outer quadrant of the right breast.

[EDIT](#)One Hospital drive, ACMF town, MO 63912  
Phone: (512) 921-1663 Fax: (512) 912-2635

Patient:	Jane Kren	Attending physician:	Dr. Meng Sharp		
Patient ID:	865YUT	Other physician(s):			
Service:	Gynecology	Operation date:	Accession date:	Signout date:	
Location:	GYN 2378	12/29/2016	12/29/2016	12/30/2016	
Facility:	Gyn 2378	DOB: 03/17/1973	Race: White	Sex: F	

## RADIOLOGY REPORT

FINAL DIAGNOSIS

HETEROGENEOUS MASS OF AT LEAST 25MM

## SUPPORTING ATTACHMENTS

SELECT MULTIPLE



## TIMELINE

[ADD TIMELINE ITEM](#)

All events

## Upcoming Events



## Multidisciplinary

23 May 2019

Point of Discussion: Post surgery review and post...  
Dr. A. Smith

## Past Events

Molecular Profile report PDF

01 May 2019

Patient confirmed with BRCA2 mutation  
Dr. J. Lee

## Radiation therapy

07 Apr 2019

Radiation to the chest wall and right axilla  
Dr. R. Stan

## Chemotherapy

05 Mar 2019

A = Doxorubicin Hydrochloride (Adriamycin) C=Cy...  
Dr. R. Stan

2018



## MRI

29 Dec 2018

After gadolinium administration, den...  
Dr. R. Spencer Radiology report PDF

29 Dec 2018

Report shows heterogeneous mass  
Dr. R. Spencer

## Breast tumor board

21 Dec 2018

Point of Discussion: New Patient  
Dr. A. SmithLaboratory tests PDF

Kren, Jane

Female, 44  
MRN 849506933

[SUBMIT TO TUMOR BOARD](#)

### CANCER INFO

Right breast  
Invasive Ductal Carcinoma NOS

c. T2 N1 M0 Stage I B

p. T2 N1a M0 Stage I B

### PATIENT HISTORY

#### APPS



Clinical Trials  
Match



Publications  
Search

### Right breast needle core ⓘ

10 Dec 2018

Invasive Ductal Carcinoma, well differentiated grade 1.

[EDIT](#)



One Hospital drive, ACME town, MO 63912  
Phone: (512) 921-1663 Fax: (512) 912-2636

## SURGICAL PATHOLOGY REPORT

Patient: Jane Kren  
Patient ID: 865YUT  
Service: Gynecology  
Location: GYN 2378  
Facility: Gyn 2378

Operation date: 12/10/2016  
Accession date: 12/10/2016  
Signout date: 12/10/2016

Attending physician: Dr. Ana Rodriguez  
Other physician(s):

DOB: 03/17/1973  
Sex: F Race: White

#### FINAL DIAGNOSIS

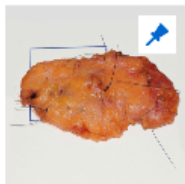
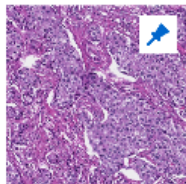
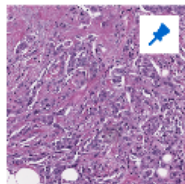
A. RIGHT BREAST MASS, UPPER OUTER QUADRANT, NEEDLE CORE BIOPSY:

TUMOR TYPE: INVASIVE DUCTAL CARCINOMA, NOS

#### SUPPORTING ATTACHMENTS

SELECT MULTIPLE

URL Links ⌵



[Link to other images](#)

### TIMELINE

[ADD TIMELINE ITEM](#)

All events ⌵

#### Upcoming Events

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29 May 2019  
Point of Discussion: Post surgery review and post...  
Dr. A. Smith

#### Past Events

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#### 2018

**MRI**  
29 Dec 2018  
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Dr. R. Spencer 

**Radiology report** PDF  
29 Dec 2018  
Report shows heterogeneous mass  
Dr. R. Spencer

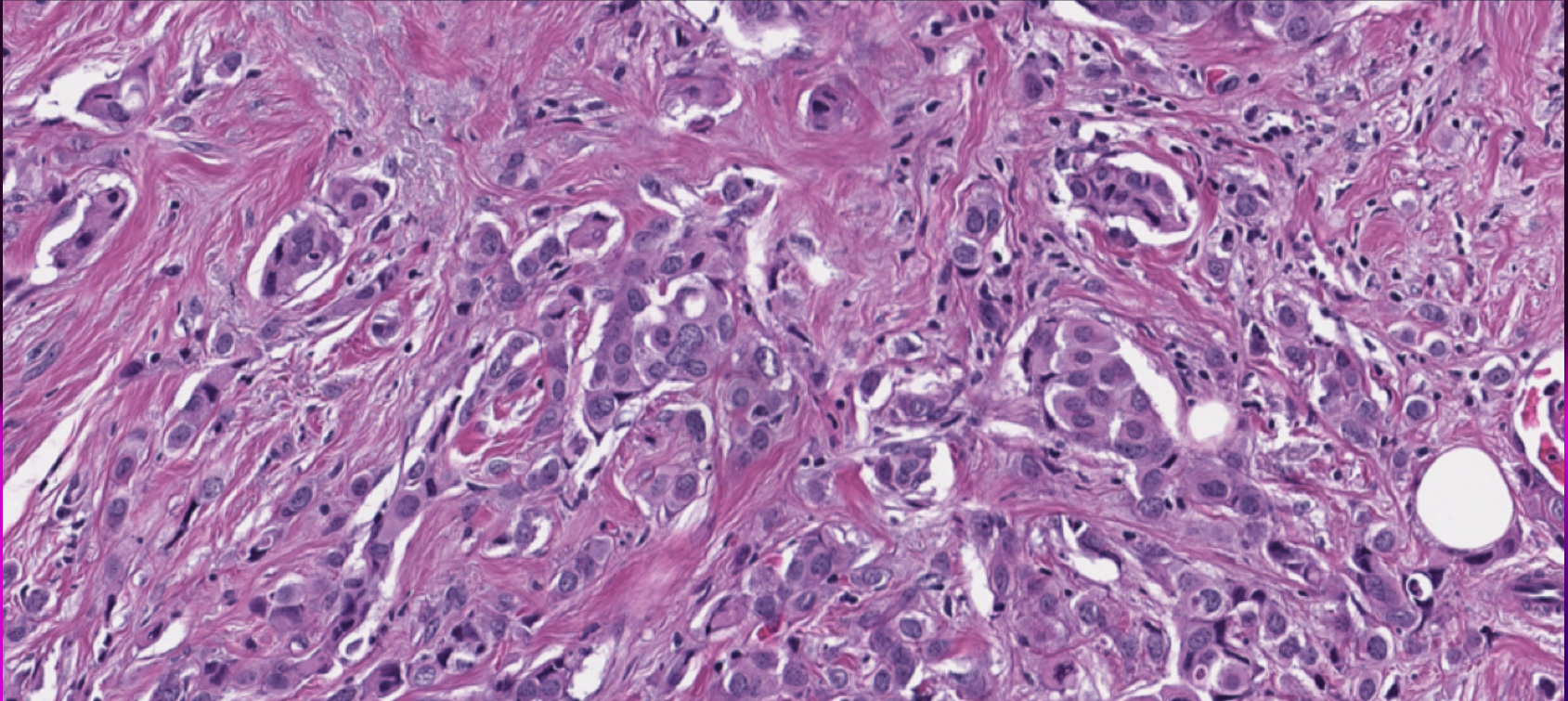
**Breast tumor board**  
21 Dec 2018  
Point of Discussion: New Patient  
Dr. A. Smith

**Laboratory tests** PDF  
19 Dec 2018  
Final report for lab tests.  
Dr. G. Max



# NAVIFY® Tumor Board

← Right breast needle core biopsy



H&E - 40x

EDIT



Kren, Jane

Female, 44  
MRN 849506933

[SUBMIT TO TUMOR BOARD](#)

## CANCER INFO

Right breast  
Invasive Ductal Carcinoma NOS

c T2 N1 M0 Stage IIB

p T2 N1a M0 Stage IIB

## PATIENT HISTORY

## APPS



Clinical Trial Match



Publication Search



Guidelines



Patient Pool

## Guidelines

Guideline Source: NCCN

Cancer Type: Breast

Guidelines Starting Point



NCCN Guideline® Breast Cancer August 2018

Noninvasive breast ca

- Noninvasive Breast Cancer:
  - Lobular carcinoma In situ (LCIS-1)
  - Ductal Carcinoma In situ(DCIS) Workup and primary treatment (DCIS-1)
  - DCIS Postsurgical treatment and surveillance/follow-up (DCIS-2)
- Invasive Breast Cancer:
  - Locoregional Treatment of T1-3,N0-1,M0 Disease (BINV-2)
  - Systemic Adjuvant Treatment
    - Hormone receptor-positive HER2-Positive Disease (BINV-5)
    - Hormone receptor-positive HER2-Negative Disease (BINV-6)
    - Hormone receptor-negative HER2-Positive Disease (BINV-7)
    - Hormone receptor-negative HER2-negative Disease (BINV-8)

Tree View

Serialized Path

+ Zoom In

- Zoom Out

## Overview

Version v1.2018

Source NCCN®

Guideline [view PDF](#)

## Tool Box

See Guideline Use History



**Kren, Jane**  
Female, 44  
MRN 849506933

[SUBMIT TO TUMOR BOARD](#)

### CANCER INFO

Right breast  
Invasive Ductal Carcinoma NOS

c	T2	N1	M0	Stage IIB
p	T2	N1a	M0	Stage IIB

### PATIENT HISTORY

#### APPS

[Clinical Trial Match](#)
[Publication Search](#)
[Guidelines](#)
[Patient Pool](#)

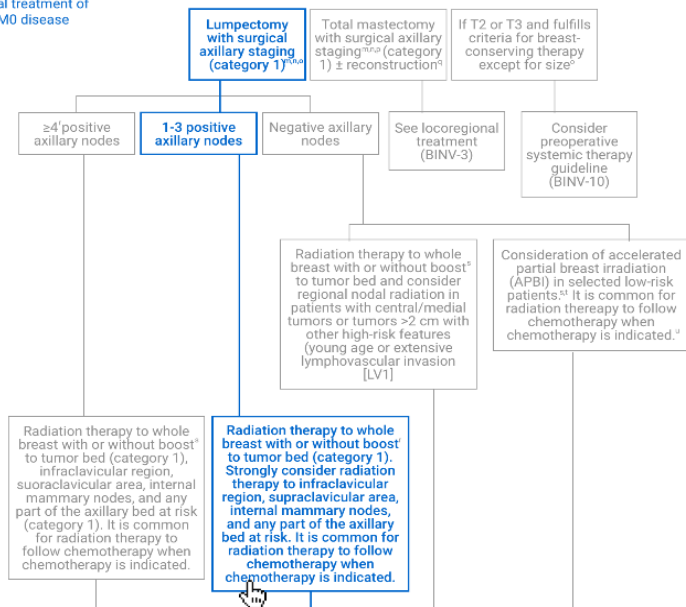
### Guidelines

Guideline Source: [NCCN](#) |
 Cancer Type: [Breast](#) |
 Hormone receptor-neg...

NCCN Guideline® Breast Cancer August 2018

Step View | [Tree View](#)

Locoregional treatment of T1-3, N0-1, M0 disease



#### Personalized Path

[+ Zoom In](#)  
[- Zoom Out](#)

### Overview

Version v1.2018  
 Source [NCCN®](#)  
 Guideline [view PDF](#)

### Tool Box

[See Guideline Use History](#)





NOT CURRENTLY AVAILABLE

Kren, Jane

Female, 44  
MRN 849506933

[SUBMIT TO TUMOR BOARD](#)

### CANCER INFO

Right breast  
Invasive Ductal Carcinoma NOS

c T2 N1 M0 Stage IIB

p T2 N1a M0 Stage IIB

### PATIENT HISTORY

#### APPS

- Clinical Trial Match
- Publication Search
- Guidelines
- Patient Pool

### Patient Pool

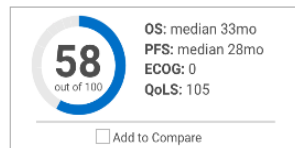
Breast TNM Staging: (T2, N1, M0) IIB First Line: N/A Second Line: N/A Female 24y-69y

Advanced Filter

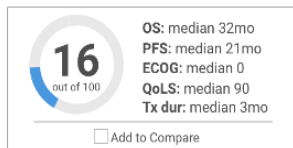
Sort by: Highest underwent

100 PATIENTS matching selected attributes

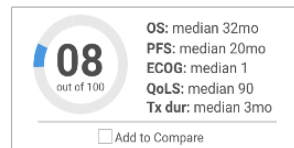
#### Lumpectomy + Whole breast radiation therapy



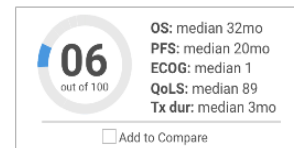
#### Total Mastectomy + Reconstruction



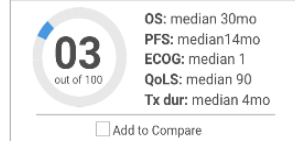
#### Lumpectomy



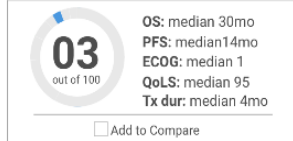
#### Adjuvant endocrine therapy



#### Adjuvant endocrine therapy + Adjuvant chemotherapy + Trastuzumab



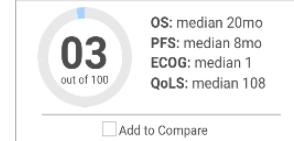
#### Adjuvant chemotherapy + Trastuzumab + Pertuzumab



#### Adjuvant chemotherapy + Trastuzumab + Pertuzumab + Endocrine therapy



#### Ado-trastuzumab emtansine





# Digital Pathology

## Evolution to digital pathology

Digitization, digitalization, digital transformation of pathology workflow **accelerates flexibility, accessibility and effectivity of all inward and outward processes with constant standardization, simplification and traceability of all operational steps**



# Digital Pathology

Evolution to digital pathology

**We are facing the beginning of healthcare, health science, medical lecturing and training integral digital transformation**





# Digital Pathology

Evolution to digital pathology

*“The best way to predict the future is to create it.”*

- Abraham Lincoln -



# Digital Pathology

## Evolution to digital pathology

### References:

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