

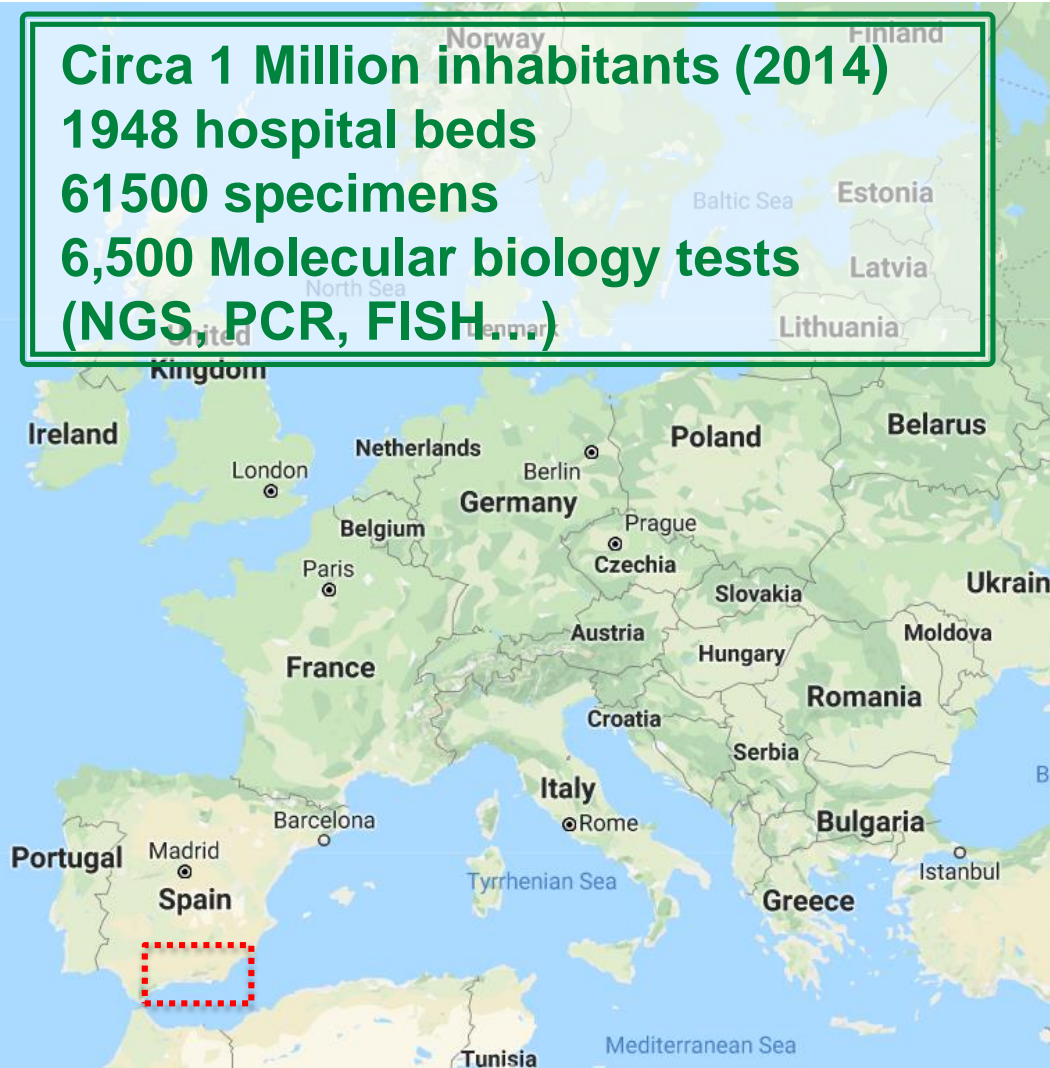
Digital Pathology Implementation Histopathology Laboratory Granada University Hospitals

Dr Juan Antonio Retamero – Pathologist
Granada University Hospitals, Spain



Granada, Spain – Please come and visit!

Circa 1 Million inhabitants (2014)
1948 hospital beds
61500 specimens
6,500 Molecular biology tests
(NGS, PCR, FISH...)



Central Pathology Lab, Granada:

- Histology specimens: 48092
- Cytology specimens : 48652
- Autopsies: 101

Virgen de las Nieves Hospital 944 beds



Granada Campus de la Salud Hospital 700 beds



Baza General Hospital

- Histology specimens : 4334
- Cytology specimens : 3789
- Autopsies: Centralized

Baza General Hospital 117 beds

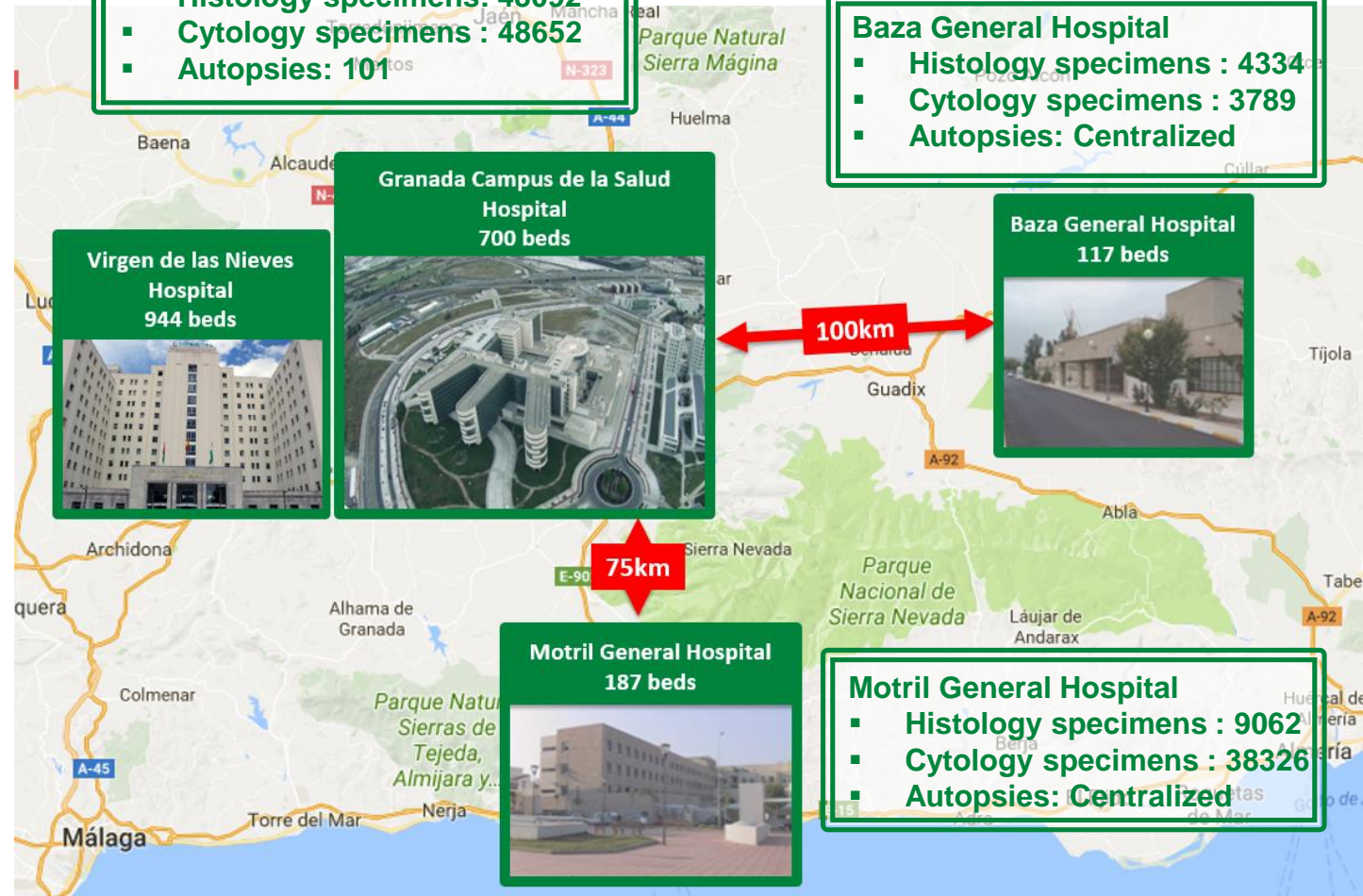


Motril General Hospital 187 beds



Motril General Hospital

- Histology specimens : 9062
- Cytology specimens : 38326
- Autopsies: Centralized



Meet our team

Granada Campus Hospital

- 21 Pathologists
- 8 Residents
- 26 Technicians
- 2 Porters
- 4 Clerical

Motril Hospital

- 2 Pathologists
- 3 Technicians

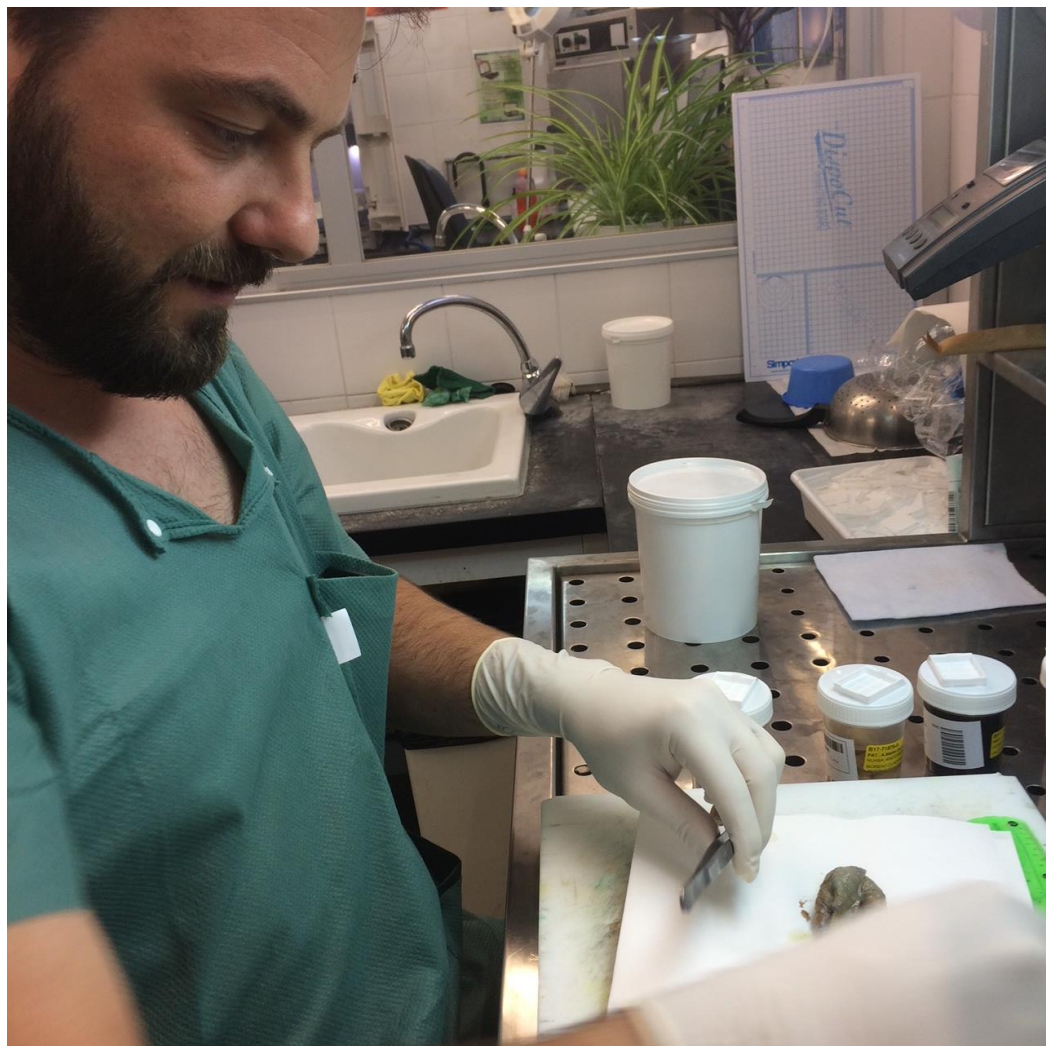
Baza Hospital

- 1 Pathologists
- 3 Technicians
- 1 Clerical



**Fully Digital for Histopathology Diagnosis
Since September 2016**

A little bit about myself...



Introducing Granada University New Hospital

Granada University Hospitals

- National Health System
- 4 networked Hospitals
 - 2 teaching hospitals
 - 2 district general hospitals
- 1 million inhabitants
- Pathology labs under same management, same IT infrastructure, & same Budget
- New hospital opened Dec. 2015



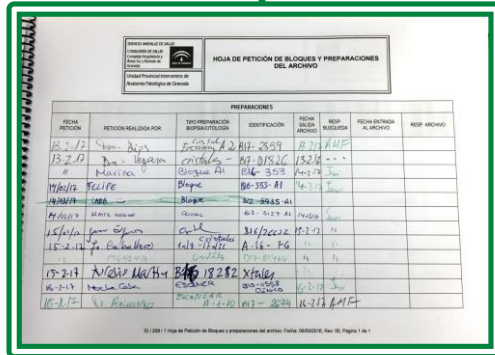
The drive force to modernize Pathology Services at GUH

- **Dr. Raimundo Garcia del Moral**
 - Vision to implement pioneering digital pathology in Spain
 - **Andalusian Government**
 - Initiative to bring Pathology Services to 21st Century
-
- Modernization of pathology services
 - Complete sample tracking
 - Test digital pathology solutions
 - Vision to do 100% diagnosis in digital



Modernization of Pathology Services

2015: Manual tracking via Notepad



FECHA PETICIÓN	PETICION REALIZADA POR	TECNICARIO ASIGNADO	IDENTIFICACIÓN	FECHA ENTREGA AL ARCHIVO	RESP. ARCHIVO
13-1-12	Dr. Díaz	Dr. Díaz	01-2859	13-1-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	
13-2-12	Dr. Díaz	Dr. Díaz	01-01510	13-2-12	



2018: Fully Integrated tracking Solution

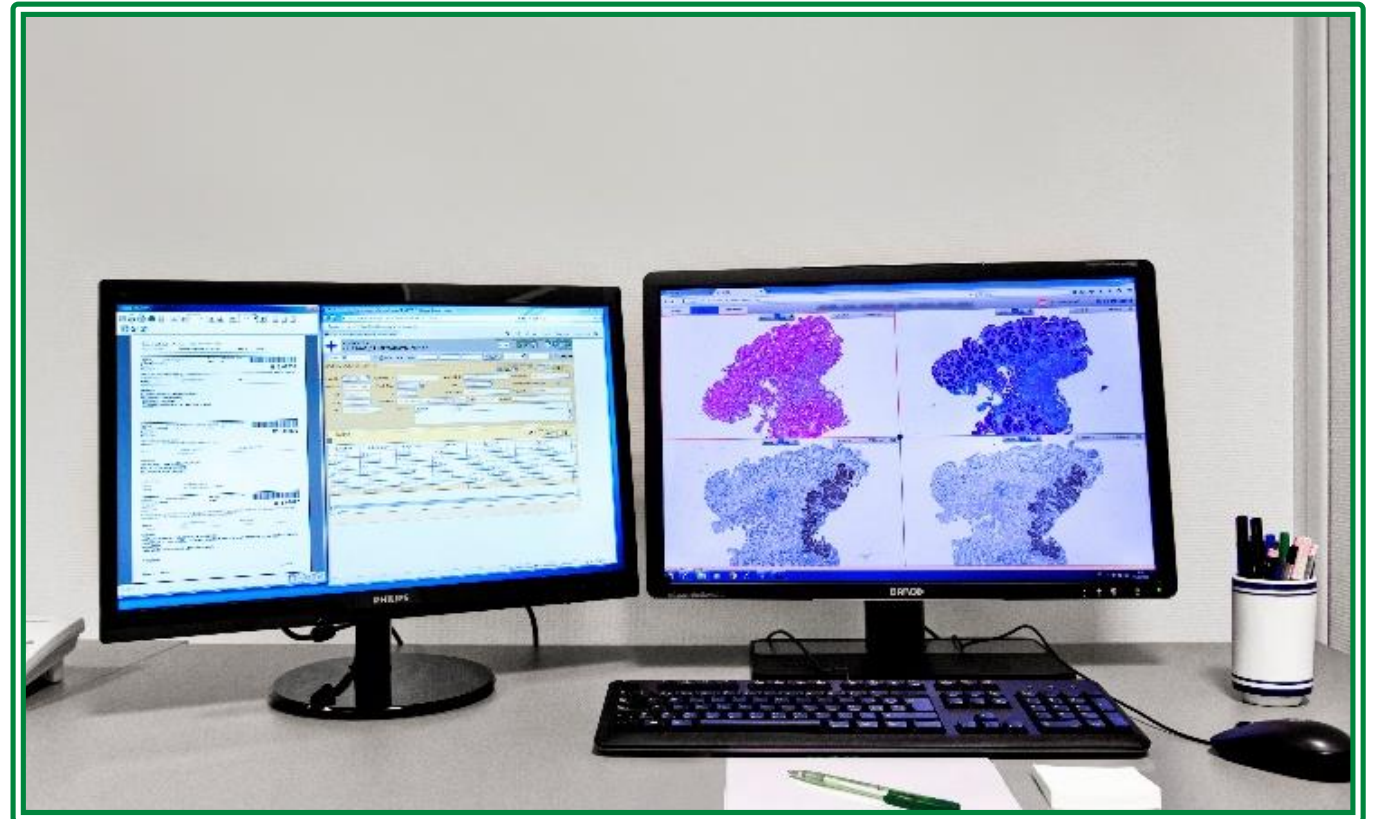


Modernization of Pathology Services

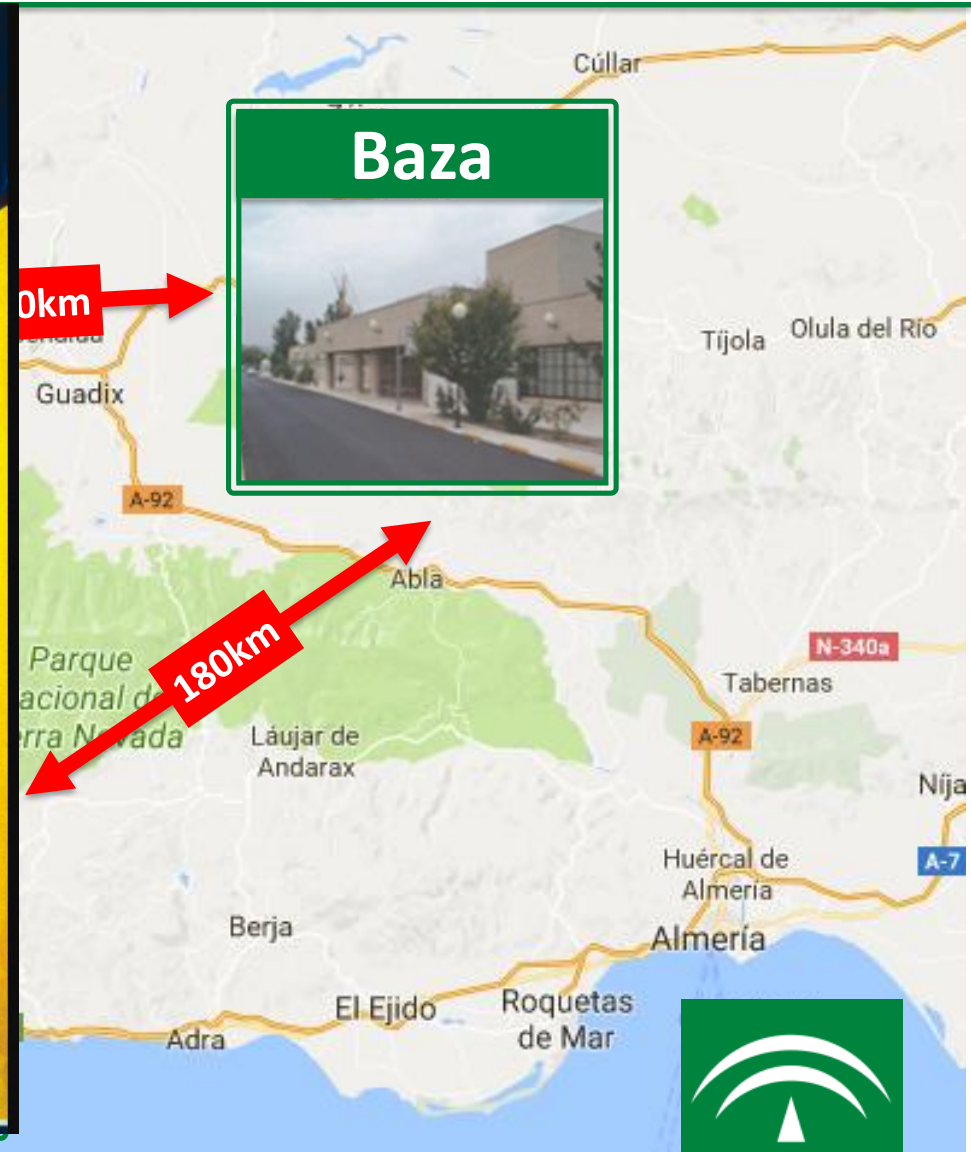
2015: Microscope and glass



2018: Digital Pathology for Primary Dx. (100% digital since 2016)



Can all 4 Hospitals be integrated together?



Phase 1 – Implementation

April 6 – May 16 2016 (40 days)

We needed answers to these questions:

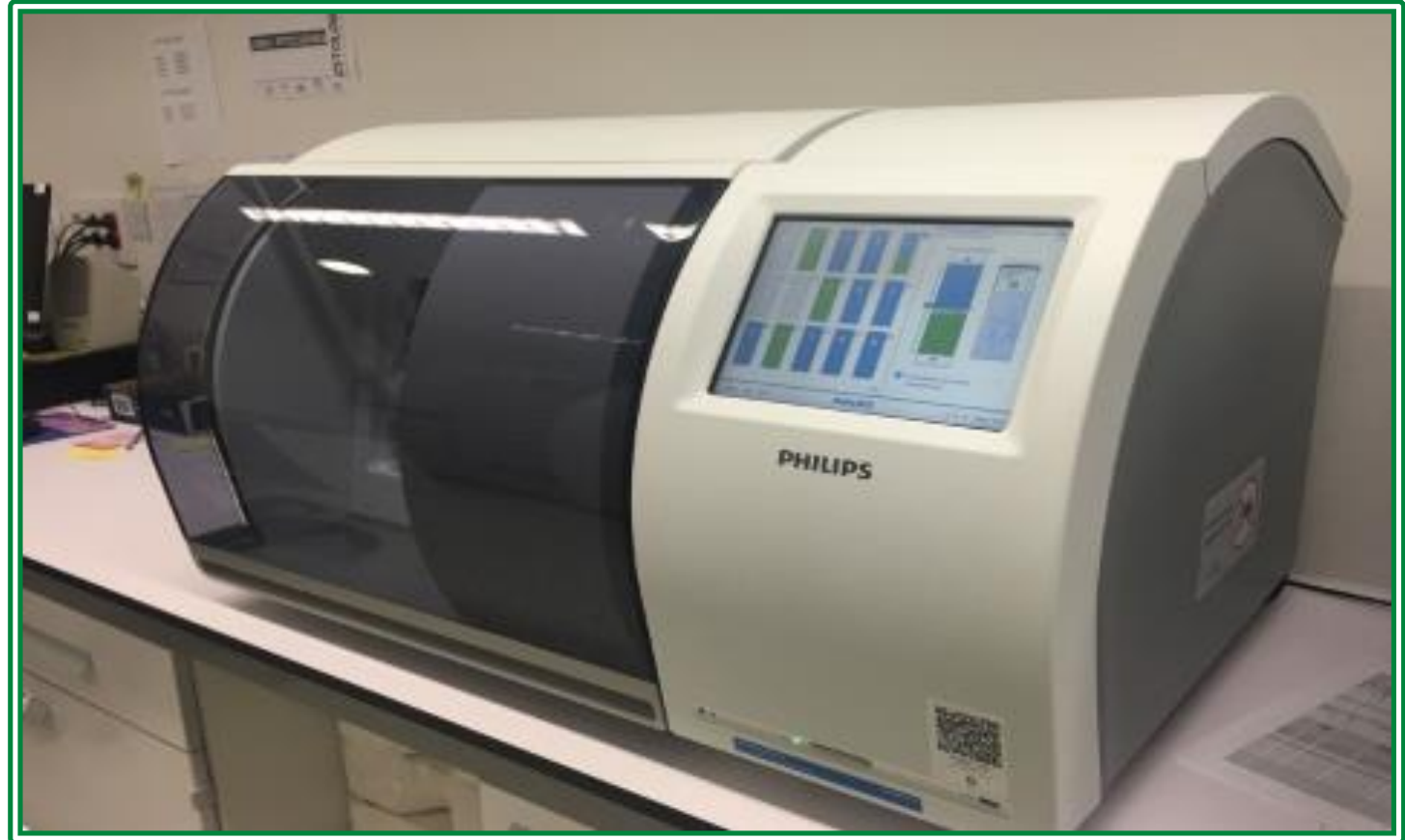
Scanning times (averages)

Best magnification

Workflow integration

Scanning capacities

Error assessment



Phase 1 – Implementation

April 6 – May 16 2016 (40 days)

Slide volume	Stain	Subspecialty	Magnification	Average speed per slide (sec)	Scanned area average (mm ²)
3357	HE, HC, IHC	Surgical Pathology	40x	121	302
2630	HE	--	40x	141	353
1547	IHC	--	40x	112	280
1323	HE, HC, IHC	Dermatopathology	40x	89	233
789	HE, HC, IHC	Uropathology	40x	108	278
9646				$\bar{x}=114$	$\bar{x}=290$ (14.5x20mm)

Phase 2 - Integration Philips IMS-LIS

May 16th – July 7th 2016 (54 days)

VitroPath® LIS

Philips IntelliSite Image
Management System

INFORMADO
ESTUDIO: 816-23959 12 09

DATOS DEL ESTUDIO

Reg. P. GARRIDO BELTRAN, J... Cop. 1

Rec. 20/10/2016 09:02 Sal. F.Val. Patólogo Aneiros Fernandez, Jose

Pet. 18/10/2016 09:01 F.Val. Patólogo Aneiros Fernandez, Jose

Inf. Res. / Cit. LOPEZ LOPEZ, NICOLAS Asoc. C15-59059

Centro Destino GRANADA - COMPLEJO HOSPITALARIO G Consultores 0 Enviar a GRANADA - COMPLEJO HOSPITALARIO G

Servicio Destino ONCOLOGIA MEDICA Diag. Clínico carcinomatosis peritoneal con AP de adenocarcinoma.

MUESTRA A

Muestra*	Tipo de Estudio	Órgano	Material remitido
A	CASO DE CONSULTA	Peritoneo - T-D4400	
B	BIOPSIA ESCISIONAL		

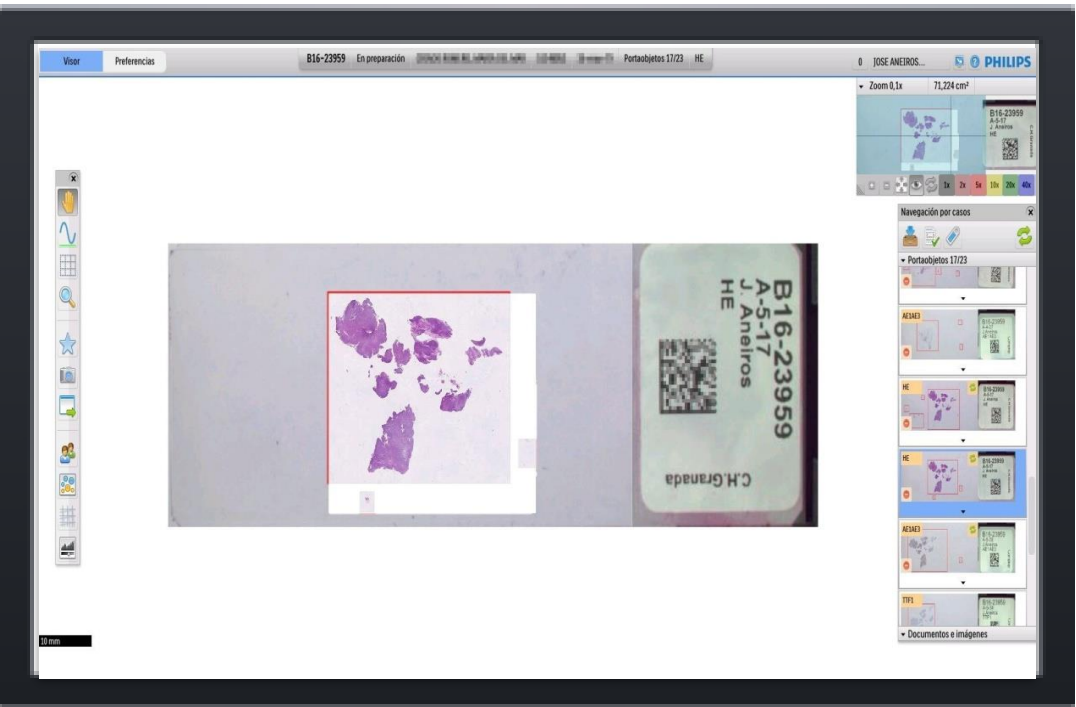
1 registros

Valoración Caso consulta 35 Foto Interesante Conservar Congelar Mic.Elec. R.T. B.B.

F.Verificación

Resp. F.Registro F.C.parcial F.Sal. F.Val.

1.Macro 2.Micro 3.Diag. Preliminar 4.Diagnóstico 5.Notas 6.Codificaciones 7.Formularios



Integration of patient & specimen data

Groundwork for digital implementation completed!

April to August 2016

All Hardware installed

All Software integrated

All testing completed



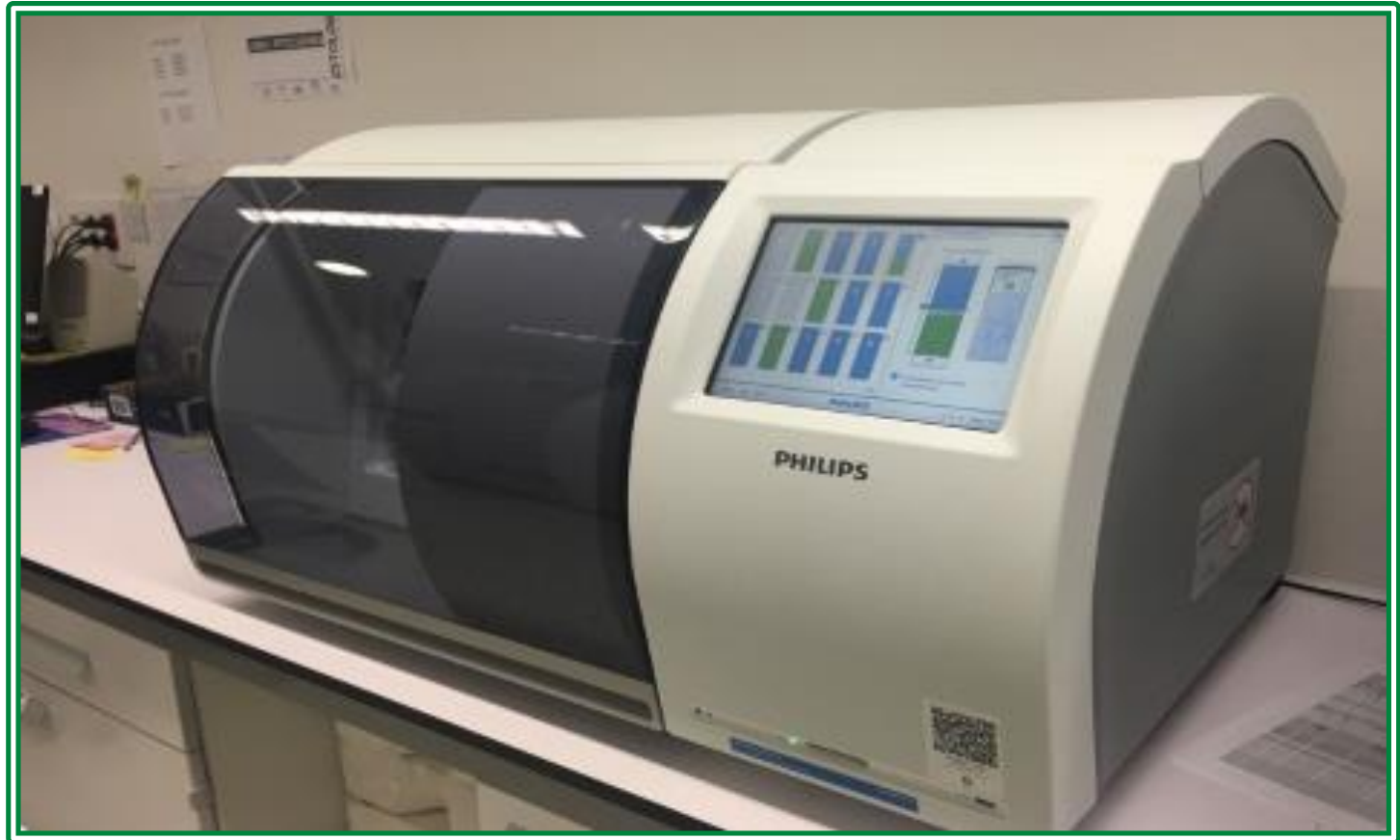
Hardware Setup

Granada Central Hospital
2x Philips UFS

Granada Central Hospital
1x 3D Histech Dark Field Scanner
IMS 3.2 compatible images

Baza Hospital
1x Philips UFS

Motril Hospital
1x Philips UFS



Hardware Setup

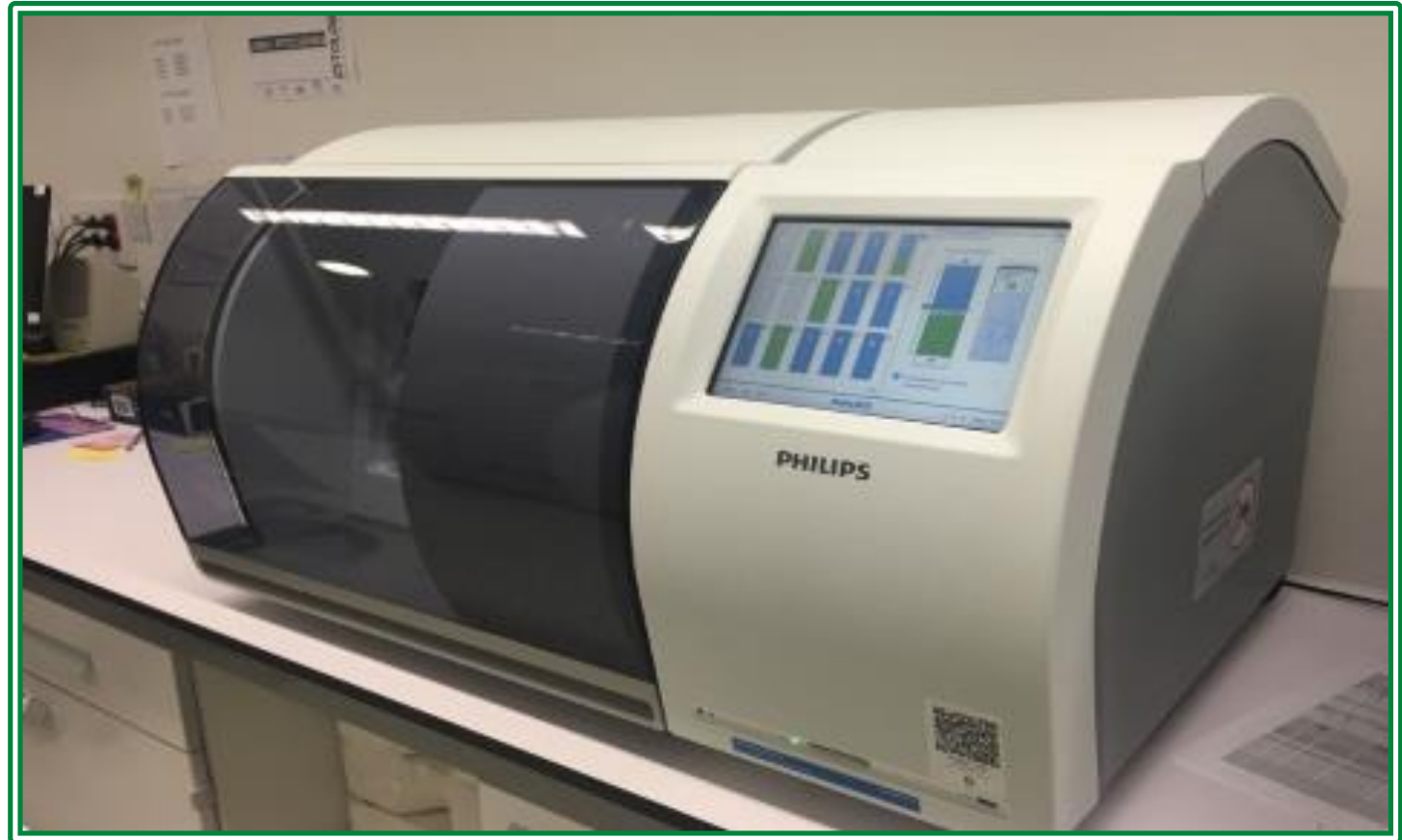
**Immediate Access Storage
350 TB**

**Long Term Storage
1PB**

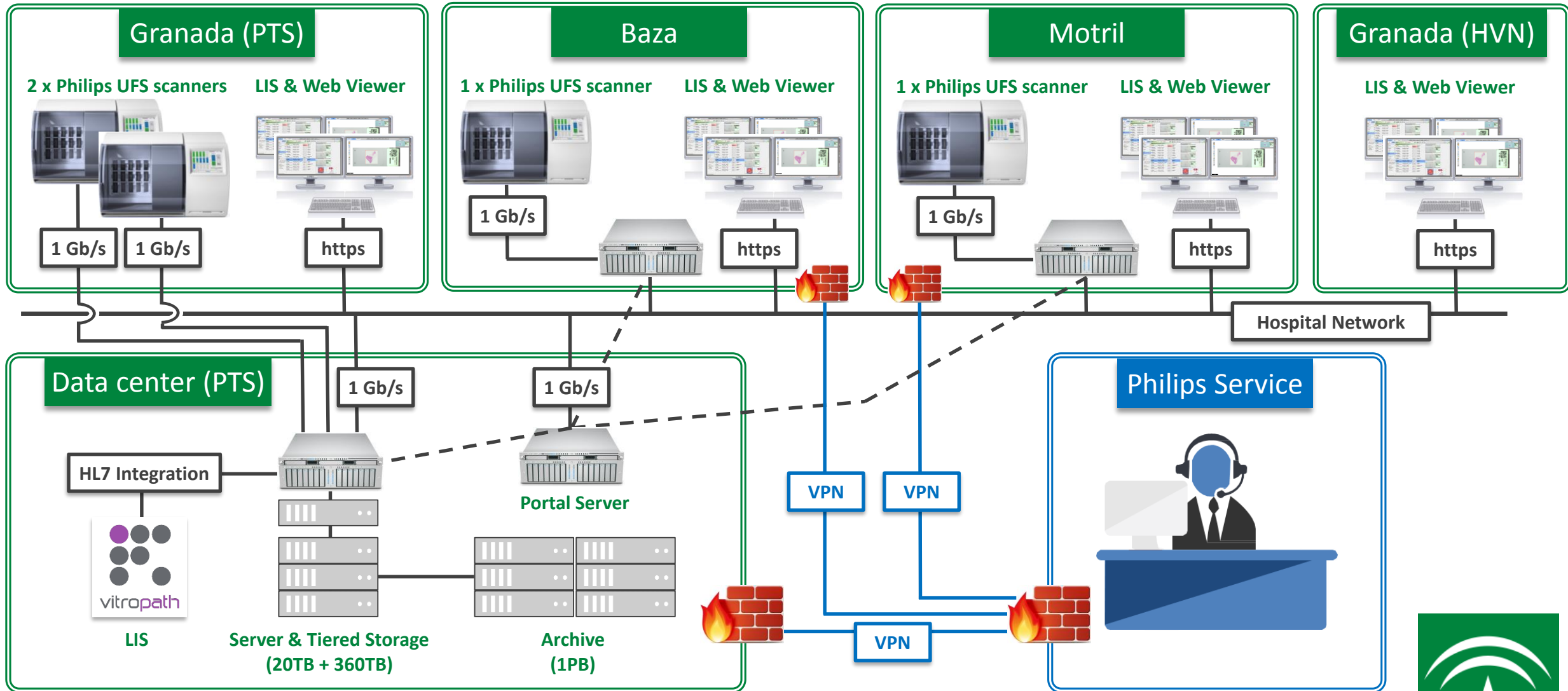
**61,000 Cases per year – We scan
everything!**

100K digitized cases, 500k Slides

5GB per Case (iSyntax format)



Granada Network - Solution Design Architecture



What does 100% digital mean to Granada and our patients?

Ability to sort caseload according to specialties and not geographical sites

Remote pathologists have access to instant expert opinion, because all cases are available anywhere within our network

Immediate access to previous cases

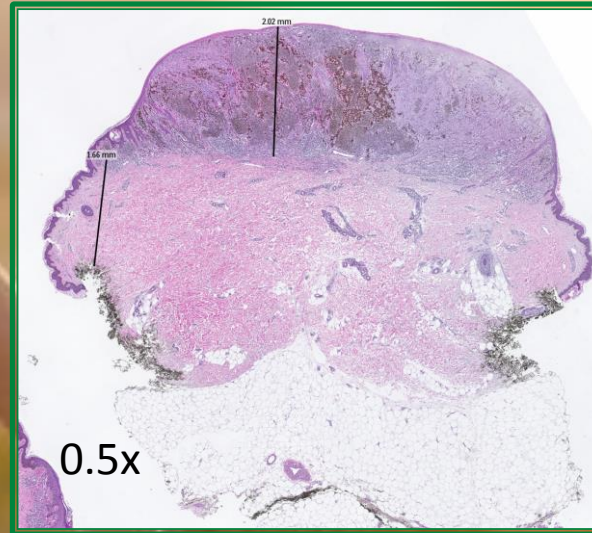
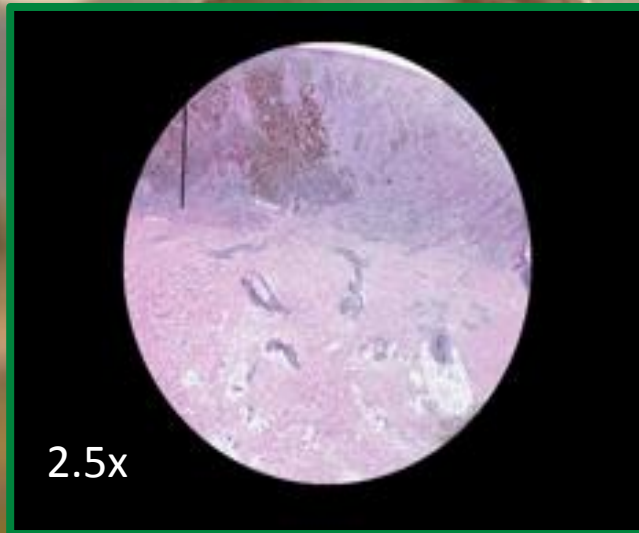
Our pathologists have access to their caseload when on call, at home...

What does 100% digital mean to Granada and our patients?



Ramon y Cajal as a medical student, circa 1876

What does 100% digital mean to Granada and our patients?



Digital tools facilitate pathologist's work

- Low power
- Grid for mitotic counting
- Measuring tools
- Immediate access to the slide you need
- Compare IHC slides side by side

100% Digital means analog workflows are redundant

No case sorting and distribution needed

Possibility to conduct consultations outside our hospital network (Philips Collaboration Suite)

Overcoming Problems

Acceptance by Pathologists

Validation Studies

Change in Habits

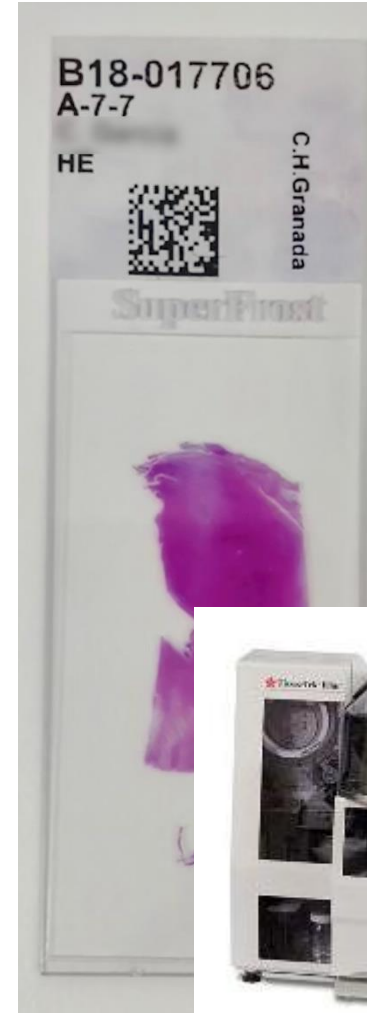


Overcoming Problems

Acceptance by Pathologists

Validation Studies

Change in Habits



**Did digitization deliver
on improving
Pathology Services?**

All testing completed

**How has digitization
impacted
Pathologists?**

**Does Digital Pathology
deliver on its
potential?**

How has digitization impacted Pathology Services?

**Conduct a user survey for
all 23 Pathologists at
Granada**

**Analyze workload and
Pathologists efficiency**

Strongly Agree ☒

Agree ☐

Disagree ☐

Strongly Disagree ☐



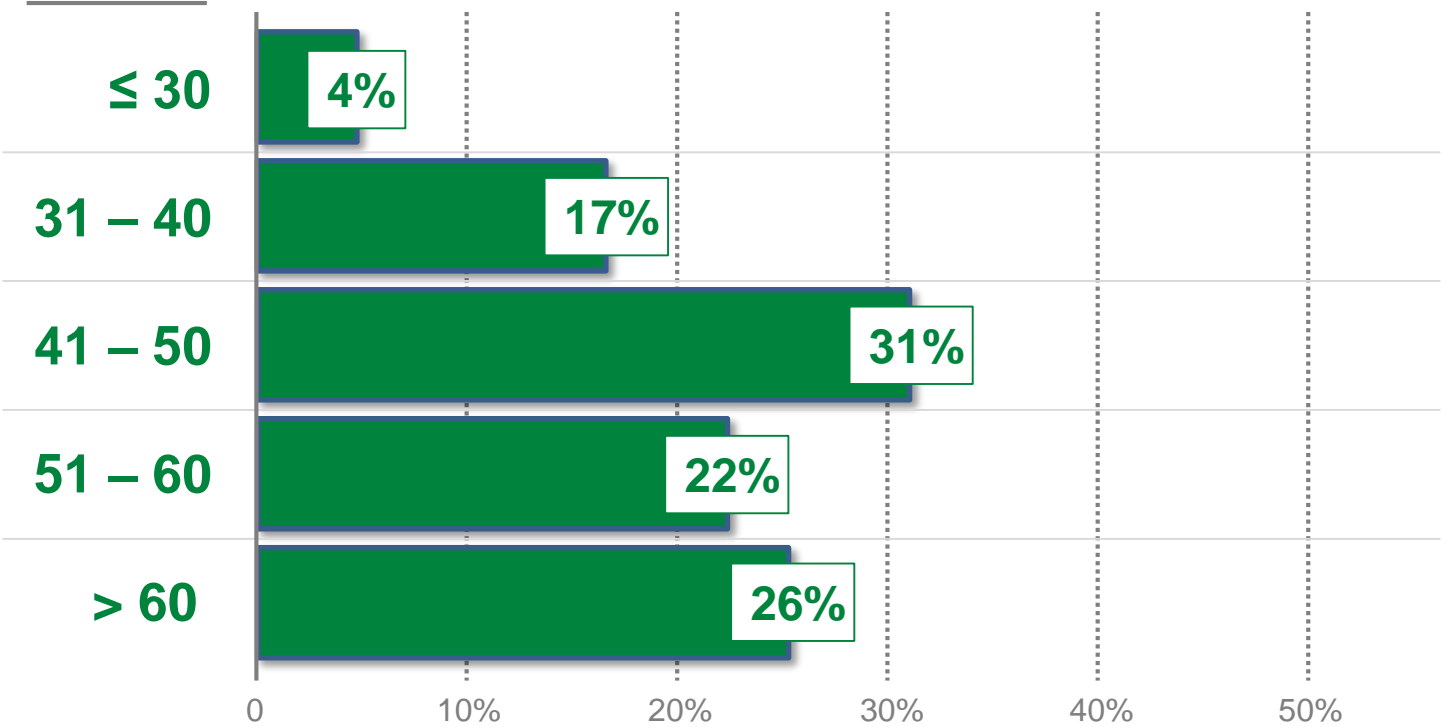
Age Distribution of Participants

Participants

- 23 Pathologists
- 23 respondents (100%)

Age Group	Respondents
≤ 30	1
30 – 40	4
40 – 50	7
50 – 60	5
> 60	6
Non respondents	0

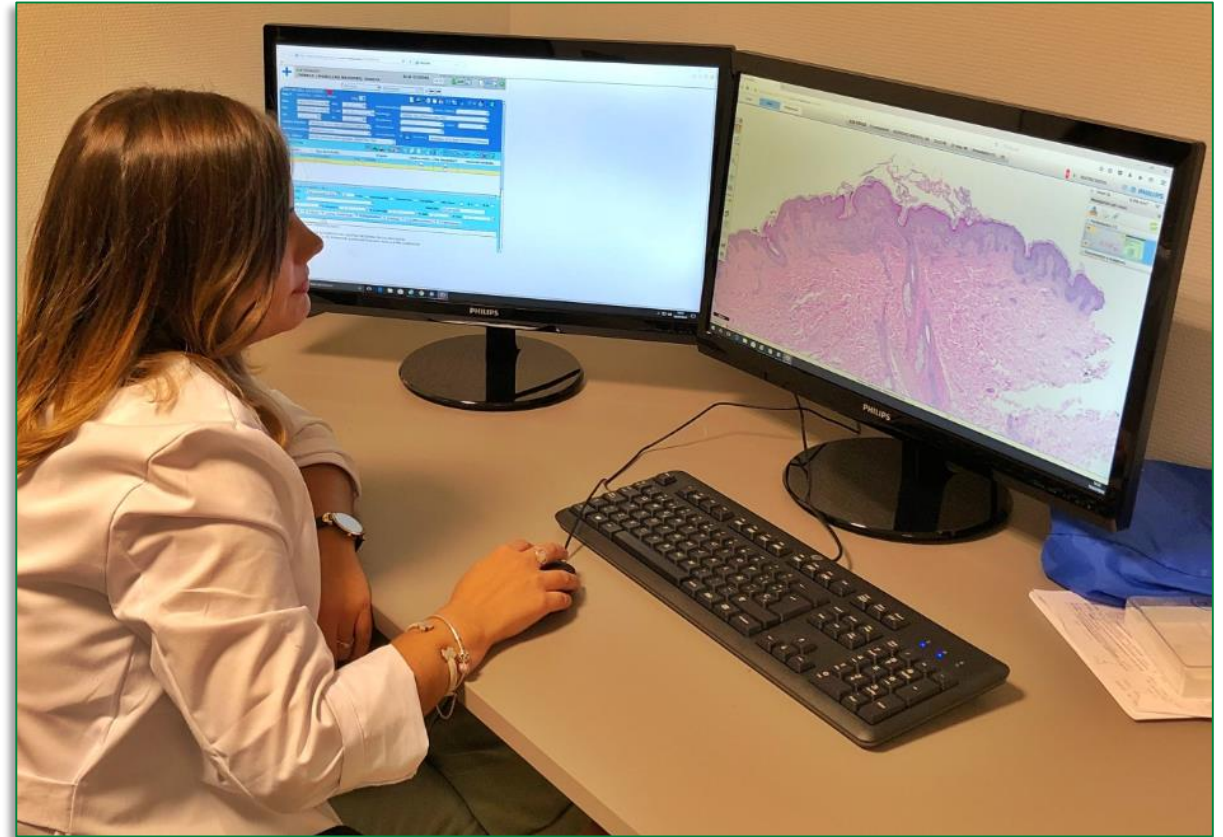
Age Group of Pathologist



Age Distribution of Participants



Dr. Miguel Cámara
Pathologist, Granada University Hospitals
Age: 66 years old
Granada's most Senior Pathologist



Dr. Beatriz Rueda
Pathologist, Granada University Hospitals
Age: 29 years old
Granada's most Junior Pathologist

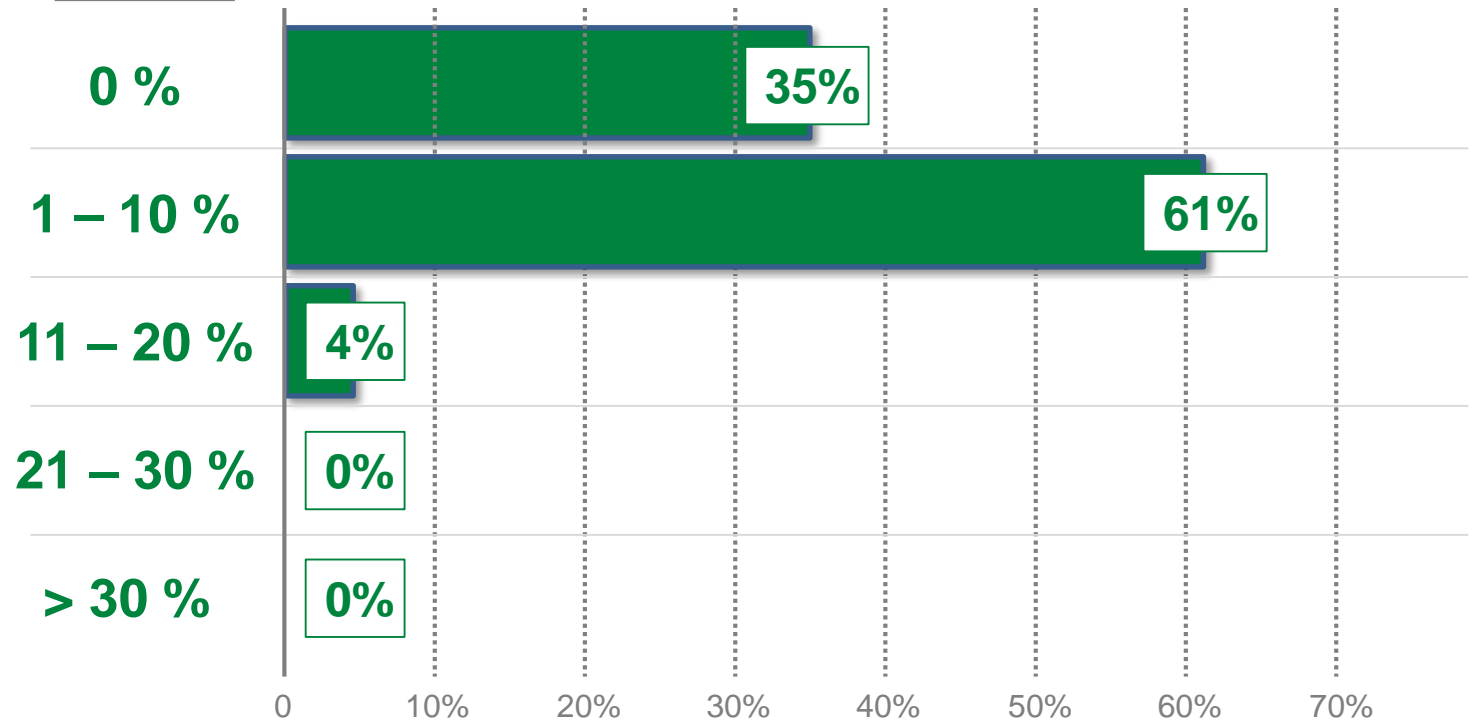
Percentage of slides reviewed on the microscope

What slides do you review optically?

- Immunofluorescence
- Polarized light
- Congo red

Percentage	Respondents
0 %	8
1 – 10 %	14
11 – 20 %	1
21 – 30 %	0
> 30 %	0
Non respondents	0

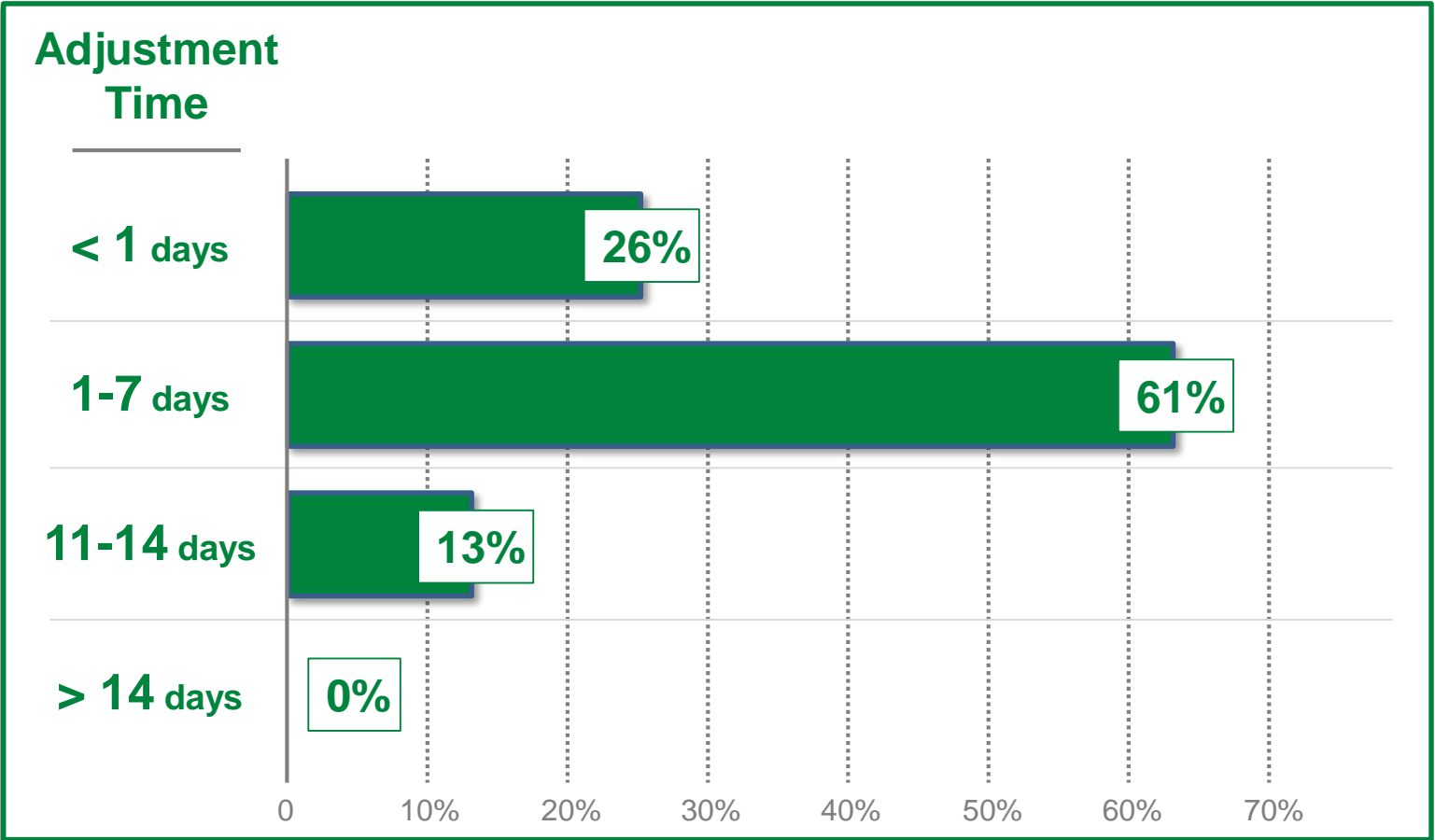
% viewed optically



Time needed to transition to Digital for routine diagnosis

How long did it take you to be ready to diagnose using digital pathology?

Adjustment time	Respondents
< 1 day	6
1 – 7 days	14
7 – 14 days	3
> 14 days	0
Non respondents	0



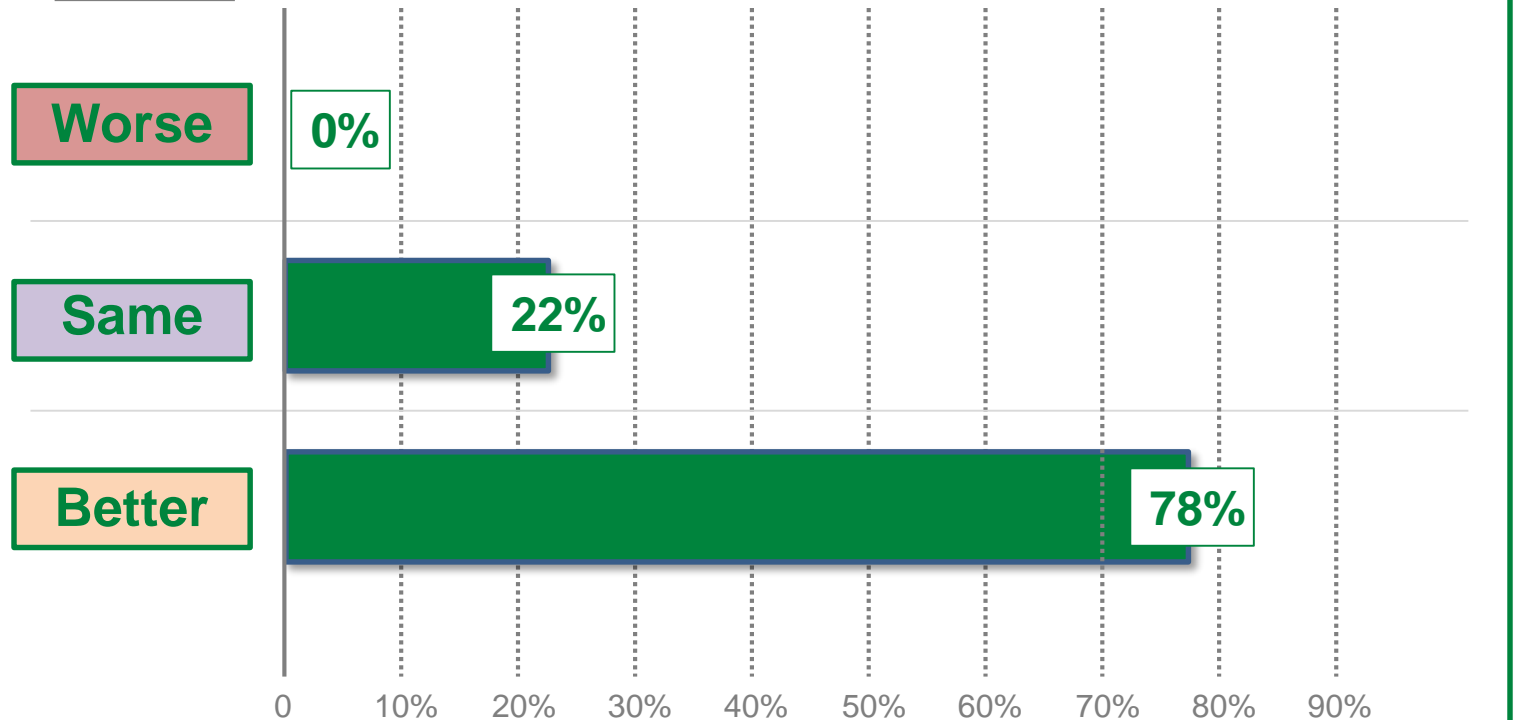
Impact of digital pathology on Quality

After implementing Digital Pathology, the quality of my diagnosis is:

- Worse than Microscope
- Same as Microscope
- Better than Microscope

Adjustment time	Respondents
Worse	0
Same	5
Better	18
Non respondents	0

Change in
quality



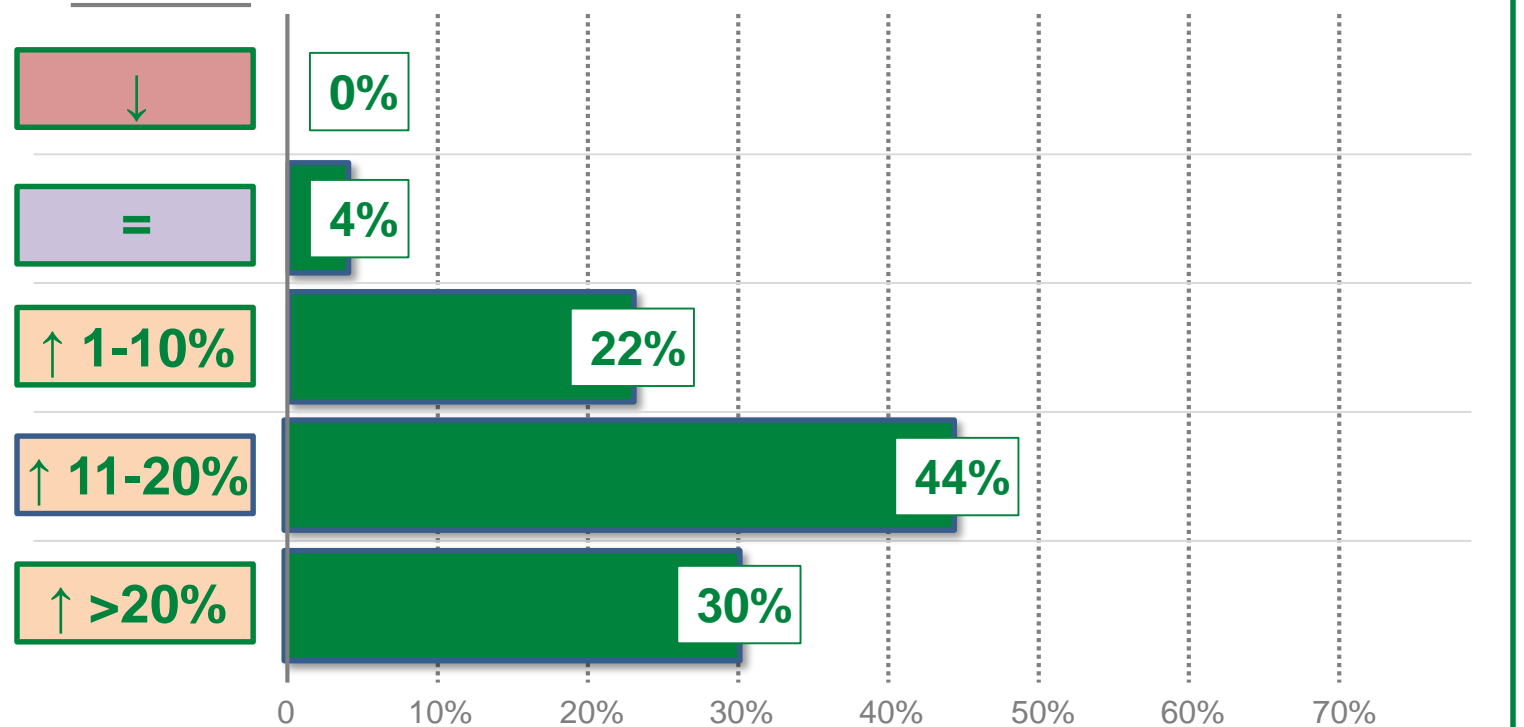
Impact of digital pathology on Efficiency

After implementing Digital, my efficiency has:

- Decreased
- Not changed
- Increased

Adjustment time	Respondents
Decreased >20%	0
Decreased 11-20%	0
Decreased 1-10%	0
Not Changed	1
Increased 1-10%	5
Increased 11-20%	10
Increased >20%	7
Non respondents	0

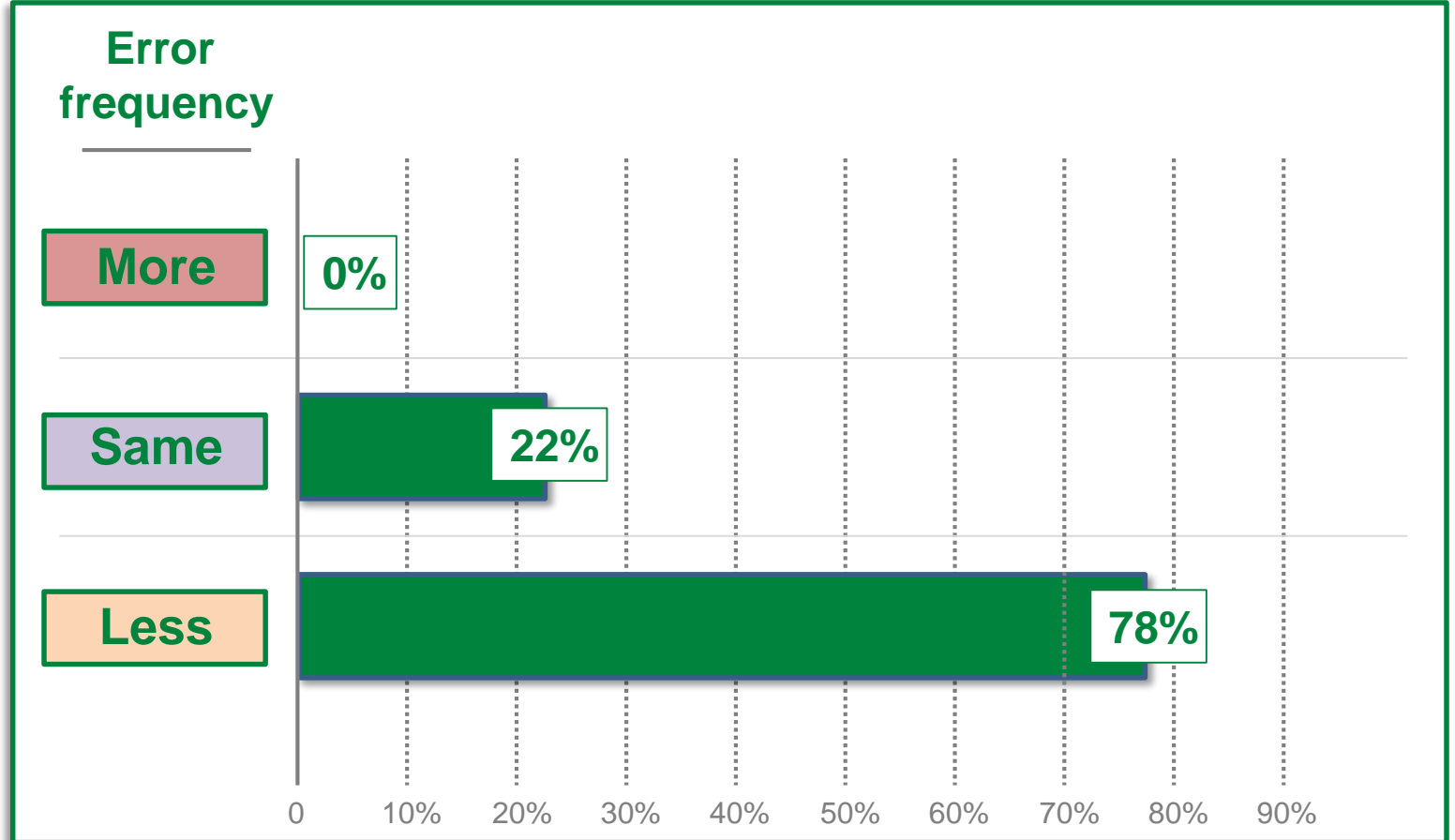
Efficiency has:



Impact of digital pathology on Patient Safety

After implementing Digital Pathology, the number of errors effecting patient safety has:

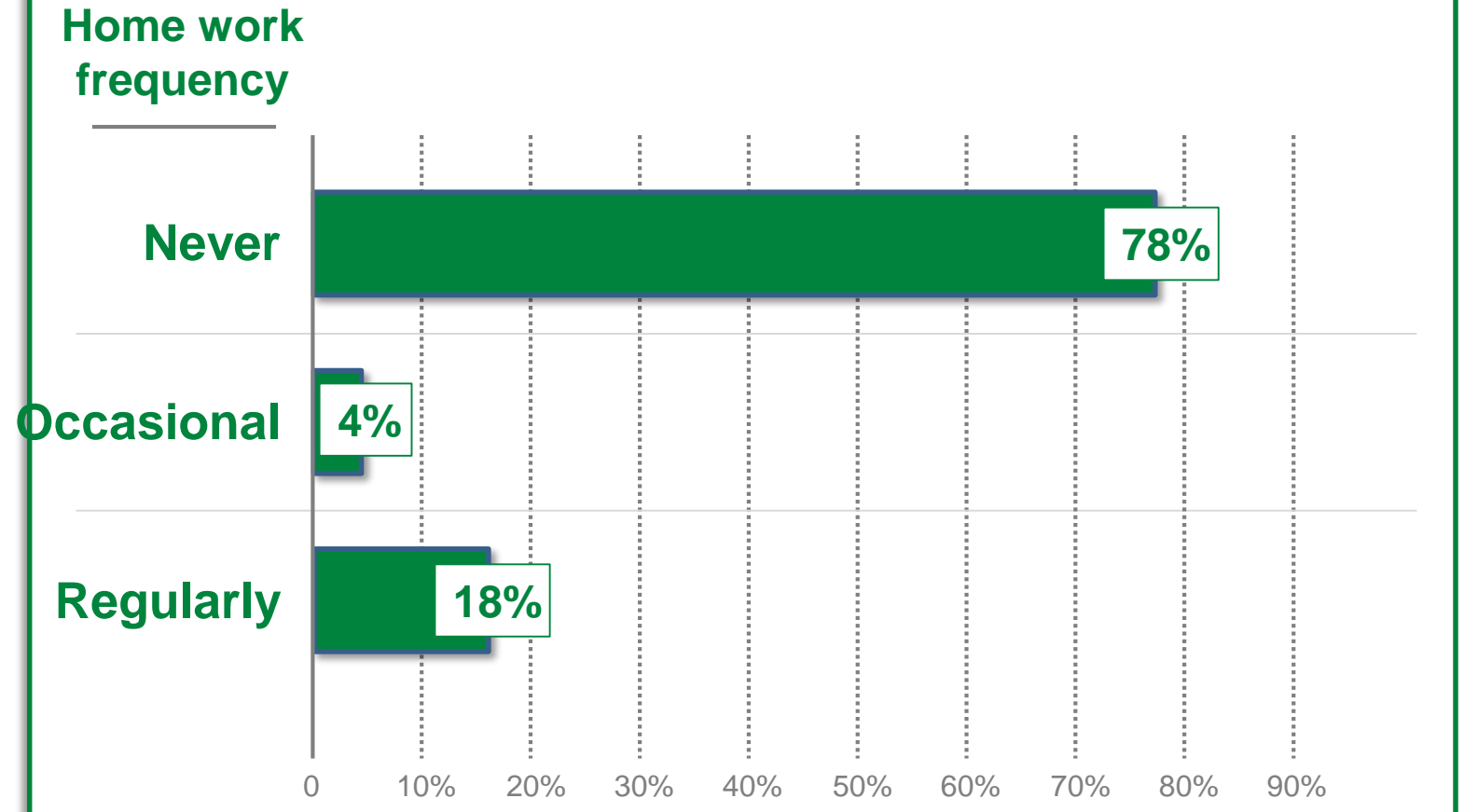
Error frequency	Respondents
More errors	0
Same	5
Less Errors	18
Non respondents	0



Impact of digital pathology on Working from Home

After implementing Digital Pathology, I work from home:

Home work frequency	Respondents
Never	18
Occasionally	1
Regularly	4
Non respondents	0

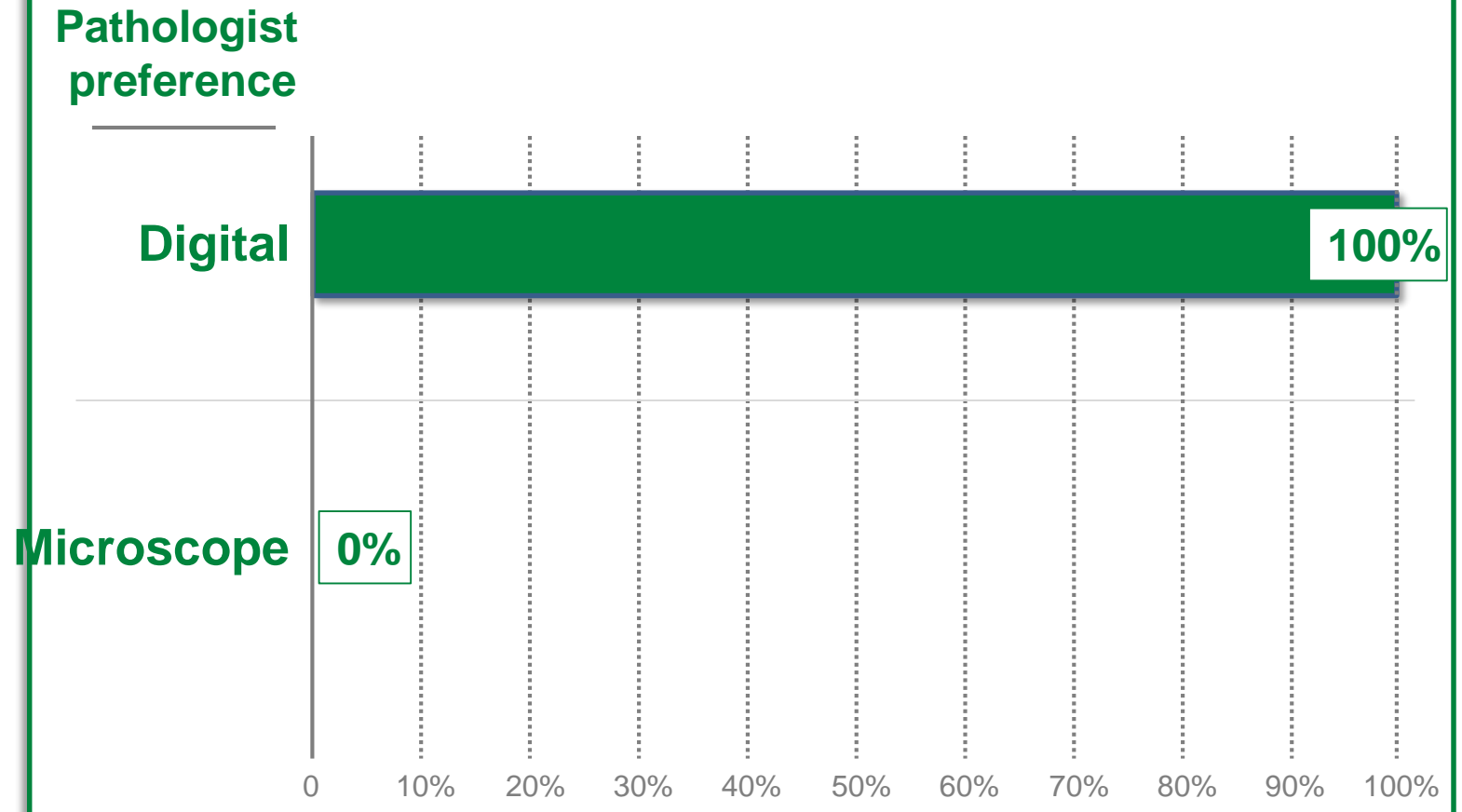


Overall experience of Digital Pathology at Granada

Having experienced working digitally, please mark your preference:

- I would prefer to continue using Digital Pathology for routine diagnosis
- I would prefer to return to using the microscope for routine diagnosis

Preference	Respondents
Digital Pathology	23
Microscope	0
Non respondents	0



Impact of going Digital in Granada

'I experience an increase in my productivity for routine diagnosis with PIPS'

96%

Experience an increase in efficiency after moving to a digital workflow

20%

Self-reported increased in efficiency

100%

'I will rather not return to the microscope after having experienced digital pathology'

'After implementing PIPS, the quality of my diagnosis is better than with a microscope'

100%

Quality of their diagnosis is the same or better than with a microscope (78% better, 22% same)

78%

Working digitally helps prevent errors in dealing with patient data due to the integration with our LIS

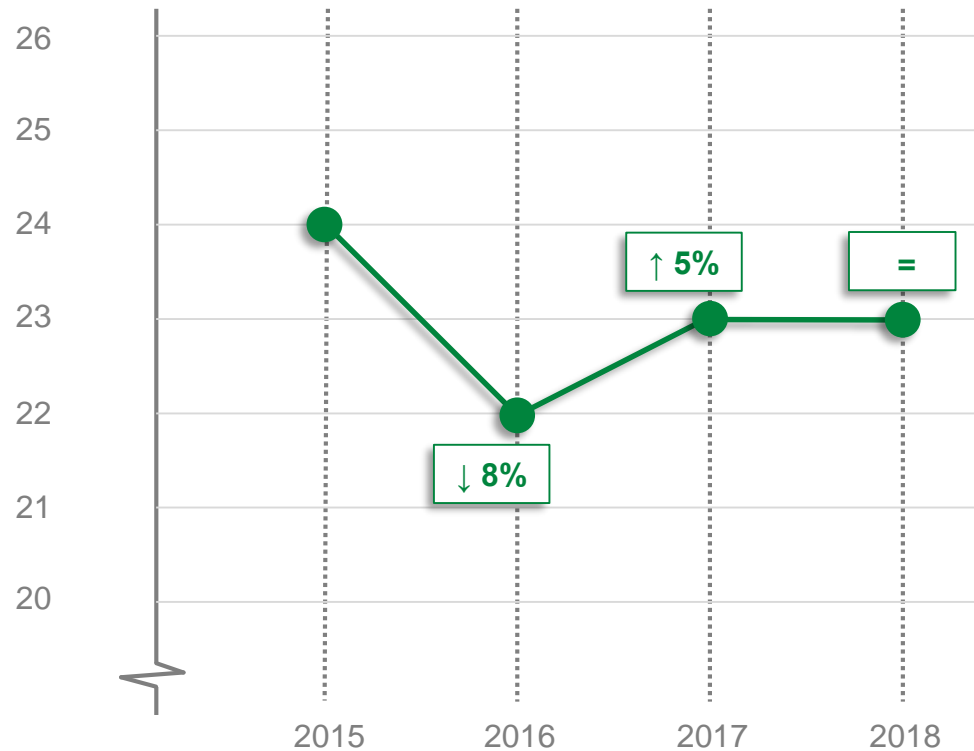
Adoption universal, amongst all pathologists and all sample types



"In essence, we are doing **more** with **less** pathologists, at the same cost **or lower** than before"

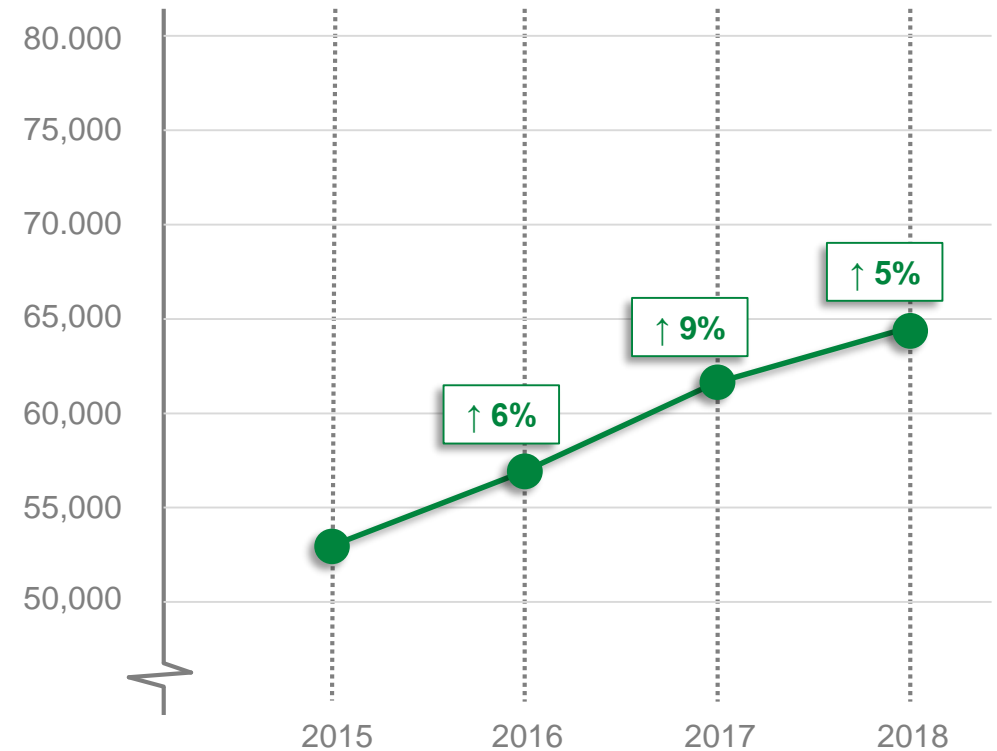
Efficiency analysis of Pathology Service at Granada

Number of Pathologists



Stable workforce. Net 1 less Pathologist versus 2015 (retirements)

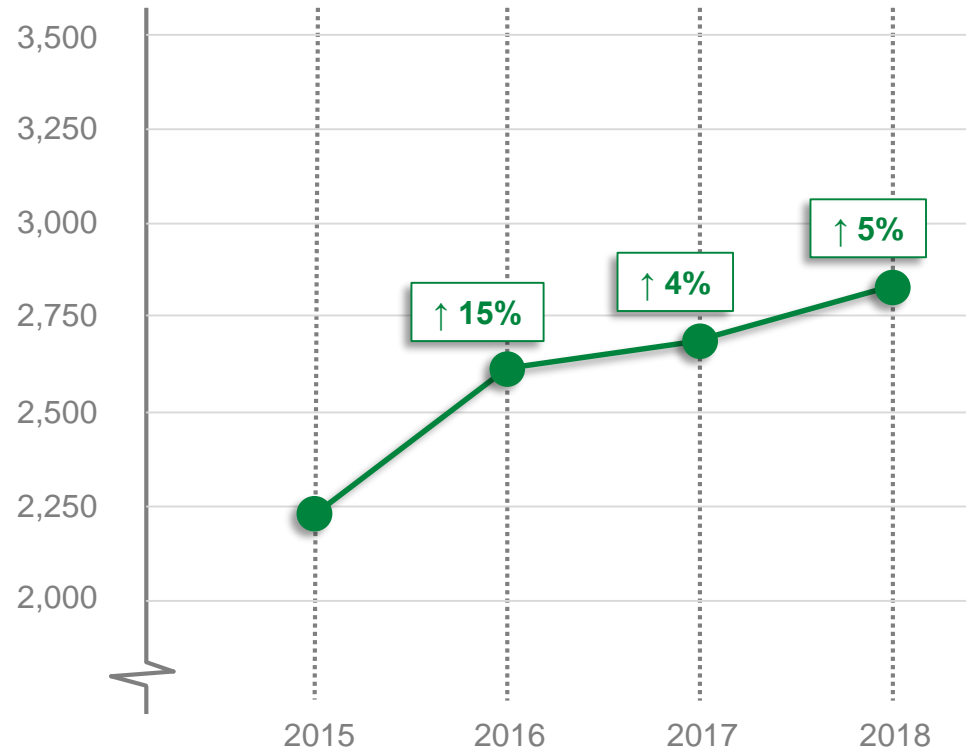
Annual caseload



21% increase in cases (2015 to 2018)

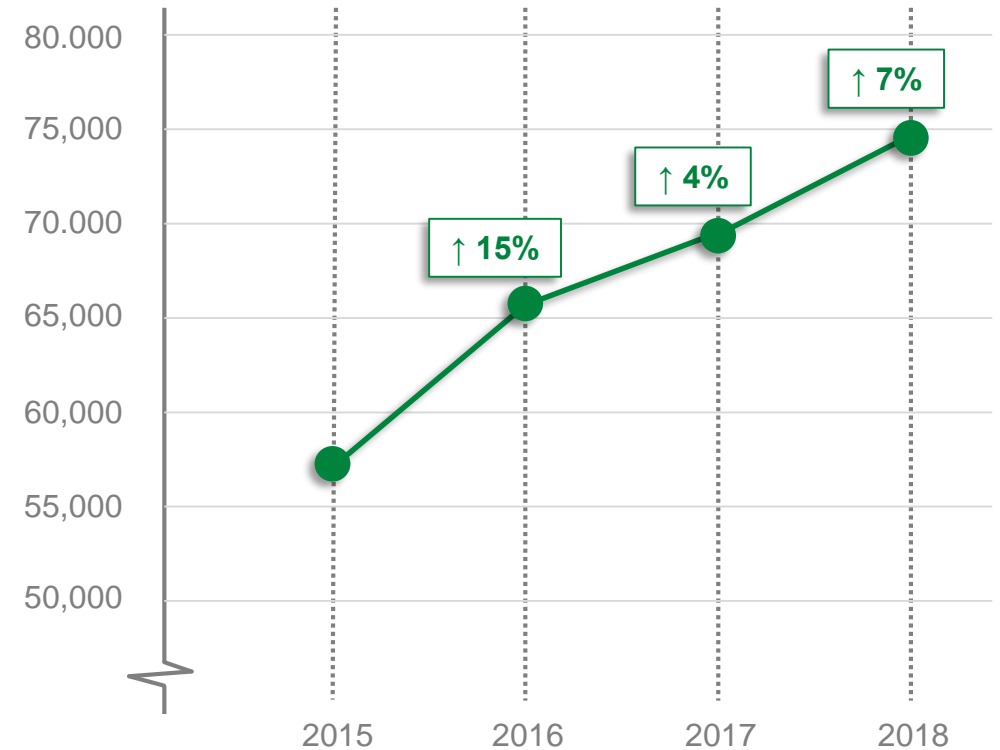
Efficiency analysis of Pathology Service at Granada

Cases per Pathologist



26% increase in cases/Pathologist (2015-2018)

RVU* per Pathologist



28% increase in RVU/Pathologist (2015-2018)

* RVU = Relative Value Units

Efficiency Improvements at Granada

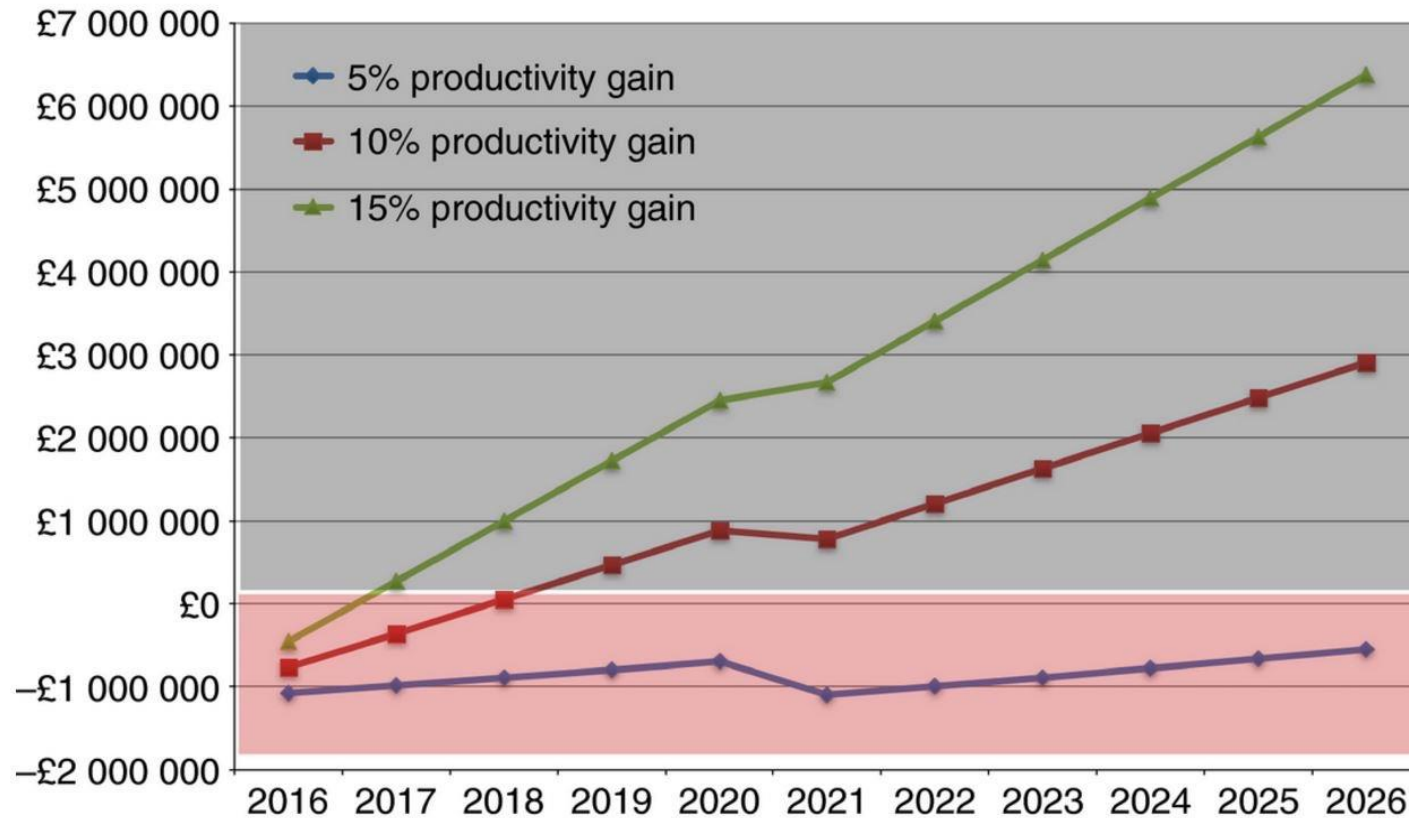
Year	Number of Pathologists	Histology Samples	Caseload Δ (year prior)	Histology cases/Pathologist	Cases/pathologist $\Delta\%$ (versus 2015)	Total RVU	RVU per Pathologist	RVU/pathologist $\Delta\%$ (versus 2015)
2015	24	53.500		2.229		1.375.544	57.314	
2016	22	56.500	6%	2.568	15%	1.450.225	65.919	15%
2017	23	61.500	9%	2.674	20%	1.581.231	68.749	20%
2018*	23	64.500	5%	2.804	26%	1.687.039	73.350	28%

*= projection calculated as of September 2018.

Caseload variation of Histopathology cases at Granada University Hospitals.

- **Less Pathologists** (retirements) relative to 2015 staffing.
- **6-9% caseload increase** on a yearly basis.
- **15-26% increased case volumes per pathologist** relative to 2015 volumes.
- **15-28% increase in RVU per pathologist** relative to 2015 activity

Cost-benefit analysis of Digital Pathology



Line graph shows the cumulative cost or benefit over time of a full-scale digital pathology adoption, under varying conditions of productivity improvement. All lines start below zero due to the large initial setup costs of digital pathology. As benefits accumulate over time, the balance of cost and benefit increases toward the positive.

- With a 5% productivity improvement, the costs are never recouped.
- With a 10% productivity improvement, the costs are recouped by year 2.
- With a 15% productivity improvement, the costs are recouped by year 1.

The model assumes all improvements in pathologist efficiency can be recouped as a financial gain.

Griffin J, Treanor D. Digital pathology in clinical use: where are we now and what is holding us back? *Histopathology*. 2017 Jan;70(1):134-145

100% Digital

... but full digitization is only a stepping stone...

On the road to Computational Pathology



On the road to Computational Pathology



Computational Pathology

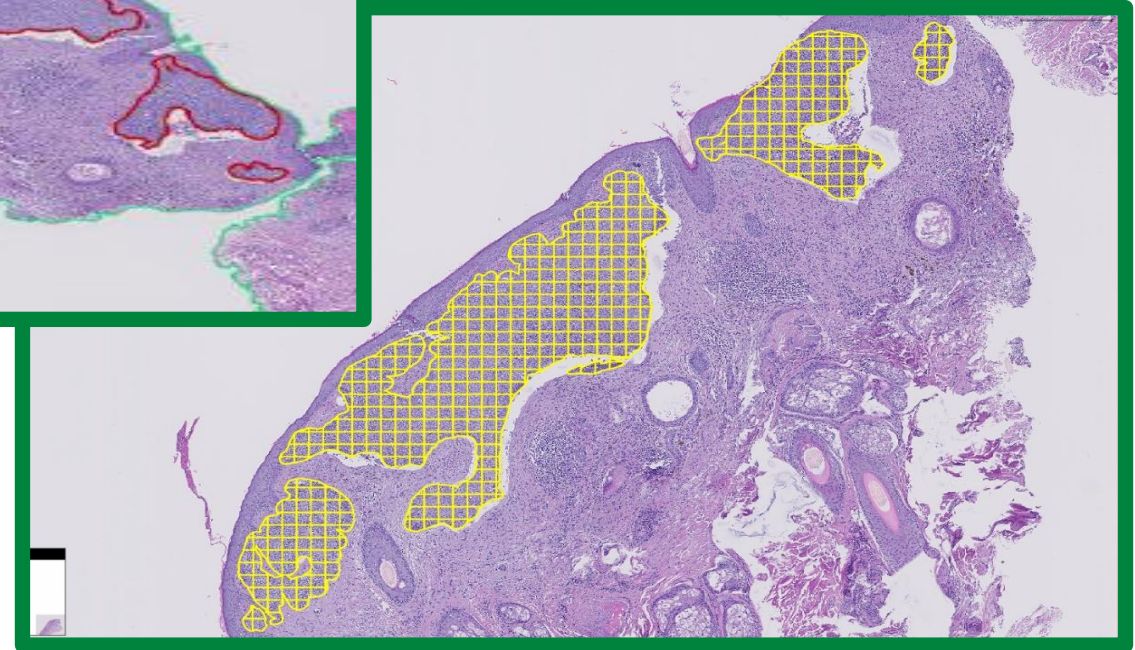
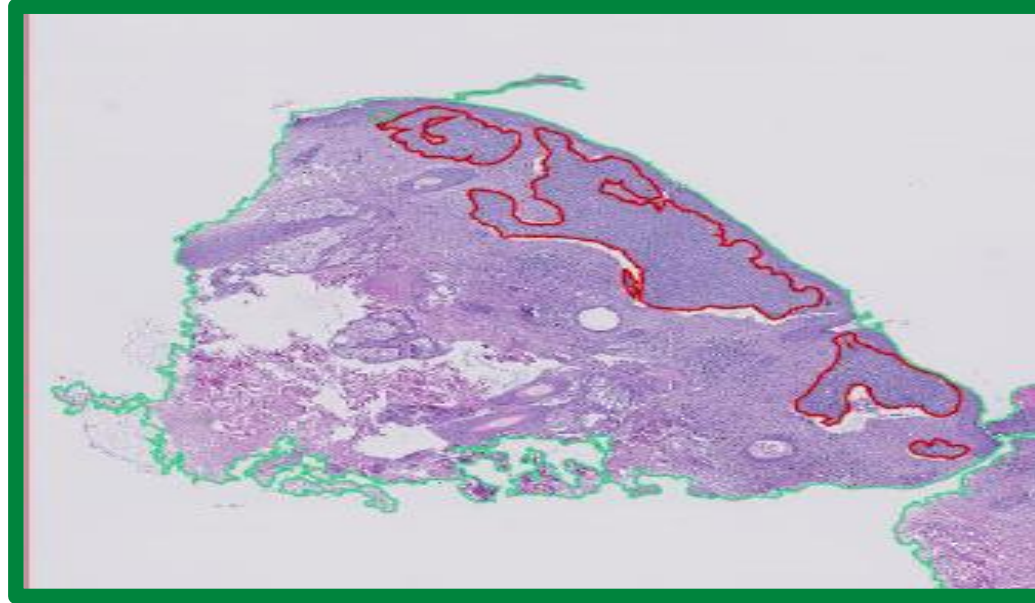
Digital Pathology

Sample Tracking

ARTIFICIAL INTELLIGENCE TOOLS TO ENHANCE PATHOLOGY DIAGNOSIS

- Image analysis
 - Use of diagnostic algorithms
 - Workflow optimization
 - Generation of preliminary reports
- Platform results (genomics...)
 - Integration of Patient Info
- BIG DATA
- CLINICAL INTELLIGENCE

Next Steps: Automatic Quantification of Skin Basal Cell Carcinoma

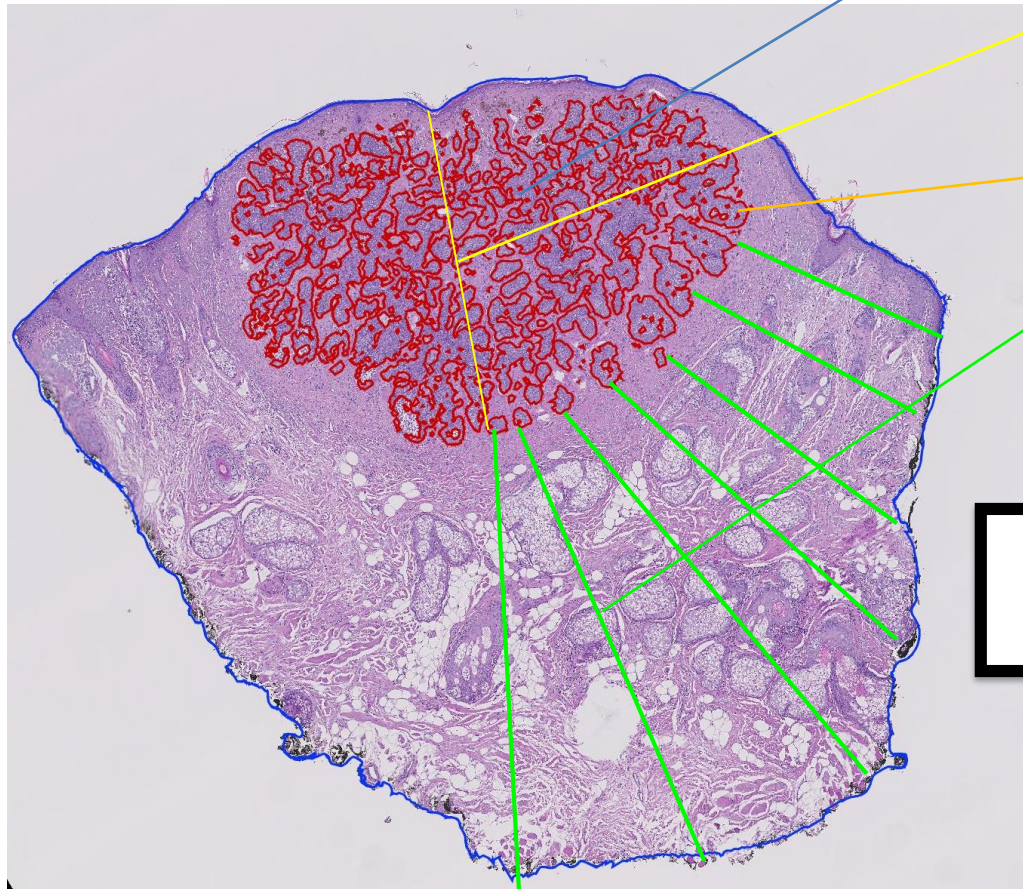


*Computational Pathology
Project in collaboration with the
University of Granada*



JUNTA DE ANDALUCÍA

Next Steps: Automatic Quantification of Skin Basal Cell Carcinoma



HISTOLOGIC SUBTYPE

TUMOUR THICKNESS

TUMOUR AREA

MARGIN STATUS



Informe de Anatomía Patológica

Entregar en: GRANADA - COMPLEJO HOSPITALARIO
GRANADA - DERMATOLOGÍA



Datos Clínicos

Carcinoma basocelular pigmentado en nariz.

Muestra

Tipo de Estudio: BIOPSIA ESCISIONAL

Fecha E. macroscópico: 10/10/2016

Técnico: GALVEZ FUENTES, MARIA DOLORES

Descripción macroscópica:

Huso cutáneo de 0,9cm x 0,5cm de diámetro que muestra una lesión central, redondeada, sobrelevada, de coloración parduzca de 0,4cm x 0,3cm, de bordes bien definidos y que se encuentra a menos de 0,1cm del margen de resección más próximo. Se seria y se incluye en totalidad en 1 bloque.

DIAGNÓSTICO ANATOMOPATOLÓGICO:

NARIZ, PIEL BIOPSIA ESCISIONAL:
CARCINOMA BASOCELULAR DE PATRÓN NODULAR CON ÁREAS MICRONODULARES DEL 23%.

ÁREA TUMORAL: 280 mm²

AUSENCIA DE INVASIÓN PERINEURAL.

MÁRGENES QUIRÚRGICOS LIBRES DE TUMOR. LA TUMORACIÓN SE LOCALIZA A 1,89 MM DEL MARGEN QUIRÚRGICO MÁS PRÓXIMO.

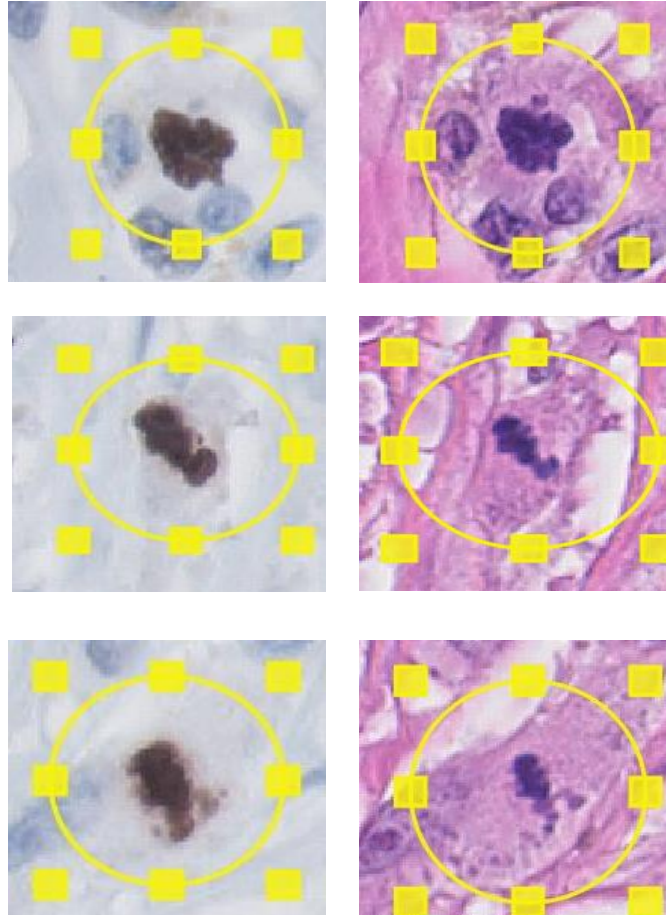
CÓDIGOS SNOMED DE LA MUESTRA: T-01000,M-80903



Next steps: Automatic Mitotic Counting in Melanoma



*Computational Pathology
Project in collaboration with the
University of Granada*



Conclusion

Digital pathology brings the profession to the XXI century, and is the foundation of computational pathology, that will change forever the role of the pathologist, and will produce Big Data for each tumour, for each patient, for each organization, for both personal and collective use (personalized medicine, clinical trials, epidemiology, cancer genetics, etc.)

Key messages

digitalhealth
news + networks + intelligence +

National digital pathology pilot
announced for Scotland



Royal Philips, NHS Greater Glasgow and Clyde and NHS Lothian announce a collaborative pilot at EHI Live for a national digital pathology service for Scotland.

The proof-of-concept pilot is designed to establish ease-of-adoption for a fully integrated and digitised national pathology service, across Scottish NHS providers.

The aim is to support standardised sample results and build a world-leading archive of reference data to increase accuracy of cancer diagnosis.

Ultimately it will offer transformational services to patients and clinicians across rural and remote areas.

NHS
SCOTLAND

**Tracking and integration
are essential to go 100%**

Get a clinical grade tool

**Image quality (40x)
FDA Approved
Reliable
Rapid
Flexible**

Test scanner

Get the right partner

**An integrated solution
makes sense**

**Digital pathology
increases efficiency (?)**

**Computational pathology
will change the profession**

Thank you

Microscopes
for sale
Granada,
Spain!

CHILDREN'S MICROSCOPE

1200X

Locusts' wings

FOR SALE

Daucus carota

