



On the Road to Digital Pathology in Denmark—National Survey and Interviews

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Abstract

Digital pathology (DP) is changing pathology departments dramatically worldwide, yet globally, few departments are presently digitalized for the full diagnostic workflow. Denmark is also on the road to full digitalization countrywide, and this study aim to cover experiences during the implementation process in a national context. Thus, quantitative questionnaires were distributed to all pathology departments in Denmark ($n = 13$) and distributed to all professions including medical clinical directors, medical doctors (MD) and biomedical laboratory scientists (BLS). For a qualitative perspective, we interviewed four employees representing four professions. Data were collected in 2019–2020. From the questionnaire and interviews, we found strategies differed at the Danish departments with regards to ambitions, technological equipment, workflows, and involvement of type of professions. DP education was requested by personnel. Informants were in general positive toward the digital future but mainly had concerns regarding the political pressure to integrate DP before technological advances are sufficient for maintaining rational budgets, workflows, and for sustaining diagnostic quality. This study is a glance on the Danish implementation process in its early stages from personnel's point of view. It shows the complexity when large new workflow processes are to be implemented countrywide and with a large diversity of stakeholders like managers, MD, BLS, IT-professionals, and authorities. To ensure best technological and economical solutions and to maintain—or even optimize—diagnostic quality with DP and workflow alignment, we suggest superior inter- and intradepartmental communication. When implementing DP countrywide, a national working group is warranted with the variety of stakeholders represented.

Keywords Digital pathology · Implementation · Qualitative · End-users · Management

Introduction

Presently, many pathology departments consider or even aim to become fully digital, which will provide new opportunities like digital assisted image analysis (DAIA) and artificial intelligence (AI) [1]. Digital pathology (DP) has for a long while been

a successful tool in research and education with limited use in primary diagnostics [2, 3], but new technological advancements have now made DP an interesting player in the diagnostic setting—not only for the DP front-runner laboratories [2, 4–7]. DP is an image-based environment that involve the work process after staining procedures: From scanning glass slides to end-diagnosis [8]. Barely a decade ago, approximately only a third of pathologists believed that the digital images had potential use in primary diagnostics [9], but with timely results and sufficient quality to ensure patient safety transferring laboratories to DP is perhaps becoming inevitable.

Implementing DP can be a national confined process [10, 11], or driven locally by laboratories [4, 12, 13]. In several countries, digitalization may not have started, but the awareness of its coming is widely accepted with a knowledge of it being a laborious and costly process [2, 4, 6, 7]. At a UK department on the brink of starting the process of becoming a DP department, employees disclosed their concerns about

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the lack of a coordinated national implementation strategy and the process was relying on ad hoc pilots and small DP deployments. The employees expressed the need for a UK national coordination for standardization and cost-saving analyses [14].

Bringing in digital pathology is an enormous step where economy, key stakeholders, and workflow possibilities will play part in decisions at the pathology departments. So how is this done best to ensure satisfied stakeholders, diagnostic quality, and patient safety? In Denmark, a national interest of implementing DP partly or fully has increased in recent few years [15]. Being a small country (5.8 million citizens), Denmark makes a national study attractive. To inspire relevant stakeholders considering DP deployments, we aim to get a national overview of experiences and approaches in an ongoing DP implementation process from both management and employees' point of view. To our knowledge, this mixed model (quantitative survey and qualitative interviews) has not been applied before on a nationwide scale to explore the implementation process of DP.

Methods

Survey

A web-based national questionnaire was distributed to personnel at Danish pathology departments using SurveyXact® (Rambøll, Copenhagen, Denmark). All personnel at the departments were invited to answer the questionnaire including clinical directors, medical doctors (MD), other academic personnel, biomedical laboratory scientists (BLS), and secretaries. Respondents were not required to work with DP. In our survey, DP was characterized as digital scanning, i.e., tissue specimens on glass slides are scanned and archived as high-resolution digital images; whole slide imaging (WSI), i.e., histological diagnostics on a scanned specimen via a computer screen also called virtual microscopy; or digitally assisted image analysis (DAIA), i.e., software assists histological diagnostics with/without AI.

Three distribution methods were applied: (1) By telephone conversations with clinical directors of the 13 pathology departments in Denmark, we encouraged the directors to distribute our questionnaire to all employees in their department. After the conversation, we send an informative e-mail with a link to the online questionnaire to the clinical director, who could forward our e-mail to employees. A flyer was distributed to post on bulletin boards at the departments to notify personnel. (2) A link to the questionnaire was posted in a Danish Facebook group “Dansk Patologiselskab” for members of the Danish Pathology Society. (3) And for members of the Danish biomedical laboratory scientist trade union (dbio), an announcement was published

in the monthly journal and on their Facebook group with an e-mail address to the authors in order to receive a questionnaire link.

Data were collected over a 3-month period from June to August 2019, and participation was voluntary, anonymous and confidential.

The questionnaire consisted of 91 questions in total and was configured in different formats, such as dichotomous, nominal multiple-choice questions, or semantic differential scale questions. Some questions had the option to add a qualitative answer, if the desired option was absent. Also, the questionnaire was tailored to the individual, so the number of questions to each respondent varied depending on certain filter questions, e.g., if the respondent was a manager or not; or worked with DP or not. The questionnaire was in the Danish language and designed to assess five main topics: (1) general information about the respondent, their department and experience in DP; (2) present DP usage, workflow, and technologies at their department and quality assurance in DP; (3) future DP strategies and ambitions; (4) education in aspects of DP; and (5) personal opinions and experiences on DP.

Data were transferred from SurveyXact to Excel Microsoft Office 365, version 1912 (Microsoft, Redmond, WA, USA) for descriptive statistical analysis. GraphPad Prism 8.4.3 (GraphPad Software, San Diego, CA, USA) was used for the Chi-square goodness of fit test and to illustrate data.

Interviews

Interviews were performed in the period November 2019–January 2020. We included four distinct types of employees, whom we found representative for a qualitative perspective on the implementation process: one medical clinical director (MCD), one clinical director of BLS (BLSCD), one chief pathologist (CP), and one BLS specialist in DP. Interviews were held in Danish and were based on a semi-structured interview guide with primarily open-ended questions, but also included unstructured open-ended questions depending on the replies of the informants. Informants were asked about their experiences with DP, their own perception of advantages and disadvantages, expectations for the development, and the reception of DP in their department. Interviews were conducted individually in order to give the informants the opportunity and freedom to express their individual views and thoughts on DP and its implementation. Written informed consent forms were obtained from informants before each interview. Approval from ethics committees were not required for either survey nor interviews [16]. Interviews were conducted at the informant's workplace, audio-recorded and lasted between 30 min and 1 h. The interviewer was accompanied with an observer to assist (both authors). Audio-recordings were transcribed using the

clean verbatim method. Data were analyzed by reviewing the transcripts and used as supplement to the survey data to pursue a mixed model method. Any included citations have been translated from Danish to English.

Results

There were 13 pathology departments in Denmark with approximately 1250 employees in total (mean (SD) = 96 (55) employees) [17].

First, survey data are shown (please note that not all questions were answered by all) and then data from interviews.

Survey

Respondent Characteristics

We received 231 completed questionnaires (215 notified by email distributed via clinical director, 15 via Facebook group “Dansk Patologiselskab,” and one from dbio journal). They represented approximately 18% of all personnel working at Danish pathology departments (20% of all MD) and included personel working and not working with DP at all departments countrywide. Hence, the five Danish Regions were represented among respondents: Capital Region of Denmark (C) $n = 68$; Region Zealand (Z) $n = 31$; Region of Southern Denmark (S) ($n = 78$); Central (Mid) Denmark Region (M) ($n = 38$); and North Denmark Region (N) $n = 16$. Represented professions in the survey were medical clinical directors ($n = 5$); clinical directors of BLS ($n = 9$); MD specialized in pathology (pathologists) ($n = 43$); MD in training for pathology ($n = 17$); other academics ($n = 6$); BLS middle managers ($n = 10$); BLS specialists ($n = 34$); BLS ($n = 93$); medical secretaries ($n = 12$); and autopsy technicians ($n = 2$).

Personnel in Danish Pathology Departments Working with Digital Pathology

From the survey, 70 respondents worked with DP throughout the last year in either research, teaching, development, or primary diagnostics and they represented 5.5% of all personnel in Danish pathology departments: C (24), Z (7), S (30), M (9), and N(0). Demographic data and years’ experience working with DP are shown in Table 1 and respondent’s responsibilities regarding DP are shown in Table 2.

Across most departments, 41 respondents not working with DP stated that their department had not started to implement DP. Perhaps the information flow may be limited, because according to personnel working with DP, all departments were in some sort of progress working toward

Table 1 Distribution of 70 respondents from the survey working with digital pathology in pathology departments in Denmark (shown in numbers (n)). Respondents were included if they answered “yes” to their department is implementing digital pathology and “yes” to working with digital pathology. Clinical Directors were excluded

| Respondents working with digital pathology | Gender | | Age group | | | | | Region | | | | | Years’ experience in Digital Pathology | | | | | | | |
|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|-----------|----------|--|--|----------|-----------|-----------|-----------|----------|----------|
| | ♀ | ♂ | ns | Age group | | | | | Region | | | | | Years’ experience in Digital Pathology | | | | | | |
| | | | | 20–29 | 30–39 | 40–49 | 50–59 | 60–69 | 70–79 | ns | Capital | Zealand | South | Mid | North* | 0–1 | 2–3 | 4–5 | 6–10 | > 10 |
| Pathologists (n = 29) | 21 | 8 | - | 1 | 10 | 11 | 5 | 1 | 1 | 1 | 12 | 2 | 14 | 1 | - | 4 | 10 | 12 | 3 | - |
| MD (n = 8) | 5 | 3 | - | 6 | 1 | - | - | - | 1 | 4 | 1 | 2 | 2 | 1 | - | 6 | 1 | 1 | - | - |
| Academic (n = 1) | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - |
| BLS Mngr. (n = 2) | 2 | - | - | 1 | 1 | - | - | - | - | 2 | - | - | - | - | - | - | 1 | - | 1 | - |
| BLS Experts (n = 13) | 10 | 2 | 1 | 2 | 4 | 2 | 2 | - | - | 3 | 1 | 5 | 4 | 4 | - | 6 | 3 | 2 | 2 | - |
| BLS (n = 11) | 10 | 1 | - | 4 | 1 | 3 | 2 | 1 | - | 2 | 2 | 3 | 5 | 1 | - | 7 | 4 | - | - | - |
| Technician (n = 1) | 1 | - | - | - | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | 1 | - |
| Secretary (n = 5) | 5 | - | - | 2 | - | 1 | 2 | - | - | - | - | 4 | 1 | 1 | - | 2 | - | - | 3 | - |
| Total (n = 70) | 55 | 14 | 1 | 8 | 13 | 19 | 17 | 10 | 1 | 2 | 24 | 7 | 30 | 9 | 0 | 26 | 20 | 15 | 9 | 0 |

MD medical doctors in training for pathology, Academic other academic (molecular biologist), BLS biomedical laboratory scientists, Mngr. middle managers, Technician autopsy technician, Secretary medical secretaries, ns not stated, Capital Capital Region of Denmark, Zealand Region Zealand, South Region of Southern Denmark, Mid Central (Mid) Denmark Region, North North Denmark Region. *) Of respondents working with DP, only the clinical director from North was represented who was working with strategy of potential implementation

Table 2 Roles in digital pathology (DP) of respondents working with DP ($n=70$) and time spent on DP. Shown in numbers (n). Multiple answers were allowed

| Respondents working with digital pathology | Digital Scanning | QA | WSI Diagnostics | QA | DAIA Diagnostics | QA | Research | Strategy | Procurement | Tech Support | Teaching | Working hours spent on DP | | |
|--|------------------|-----------|-----------------|----------|------------------|----------|-----------|----------|-------------|--------------|-----------|---------------------------|----------|----------|
| | | | | | | | | | | | | < 25% | 25–50% | > 50% |
| Pathologists ($n = 29$) | 13 | 1 | 14 | 5 | 3 | 2 | 8 | 5 | 5 | 1 | 2 | 29 | 1 | 1 |
| MD ($n = 8$) | 5 | – | 2 | – | 1 | 1 | 3 | – | – | – | – | 8 | – | – |
| Academics ($n = 1$) | 1 | 1 | – | – | – | 1 | 1 | 1 | – | – | 1 | – | 1 | – |
| BLS mgr.: ($n = 2$) | 2 | 1 | – | 1 | 1 | 1 | – | – | – | – | 1 | 1 | 1 | – |
| BLS experts ($n = 13$) | 9 | 6 | 2 | 2 | 1 | 3 | 3 | 1 | 4 | 4 | 5 | 9 | 2 | 2 |
| BLS ($n = 11$) | 6 | – | 1 | – | 1 | – | 2 | 2 | 1 | – | 1 | 11 | – | – |
| Technician ($n = 1$) | 1 | – | – | – | – | – | – | – | – | – | – | 1 | – | – |
| Secretaries ($n = 5$) | 4 | 4 | – | – | – | – | – | – | – | 1 | – | 4 | – | 1 |
| Total ($n = 70$) | 41 | 13 | 19 | 8 | 7 | 8 | 17 | 9 | 10 | 5 | 10 | 63 | 4 | 3 |

MD medical doctors in training for pathology, Academics other academics (molecular biologists), BLS biomedical laboratory scientists, mgr. middle managers, expert specialized experts, Technician autopsy technician, Secretaries medical secretaries, QA quality assurance, WSI whole slide imaging, DAIA digitally assisted image analysis

implementing DP. 106 respondents not working with DP (excluding 14 clinical directors), stated their department had started to implement DP, but were not themselves included in the process. Of those, 58% (62/106) stated it was not possible, e.g., not relevant to their jobs or department had not come far with DP. 30% (32/106) would like to work with DP in the future, and only 4% (4/106) did not want to work with DP (8% did not give an answer).

For the potential of DP, there was a significant difference ($p = 0.02$, Chi-square) between personnel working with DP versus not working with DP (including 14 clinical directors), and notable was that more personnel in the group actually working with DP believed that DP only has limited potential and relevance for few analyses (Fig. 1A).

Management and Ambitions of Digital Pathology in Danish Pathology Departments

At all departments, managers claimed they were in some process of implementing DP; this included departments that were in a planning/consideration phase: 23% (3/13) started the DP process within the last year, i.e., in 2018/2019, 15% (2/13) within the last 2 years, 31% (4/13) in the last 5 years, 23% (3/13) in the last 10 years, and none (0%) in the last 15 years (one unknown). Of personnel working with DP, 74% (52/70) were taking part in the actual implementation process. Of these, absence of implementation strategies was found to be challenging by 42% (22/52), which was most evident among staff at one department in Region C (75% (6/8)) and Region Z (67% (4/6)), and least evident at the largest department in Region S where only 12.5% (2/16) experienced absence of implementation strategies. See Fig. 1B for professions participating in DP implementation; and Fig. 1C; D for management ambitions.

Figure 2 shows expected future roles of various professions in DP based on answers from management ($n = 24$).

Technological Equipment in Danish Laboratories

For DP implementation, new hardware and software must be installed, but of personnel working with DP implementation 46% (24/52) found the physical surroundings in the laboratories to be challenging, e.g., lack of space, IT infrastructure, or electrical availability.

Scanners

Hamamatsu Nanozoomer scanners (Hamamatsu Photonics, Hamamatsu City, Japan) were used at most departments,

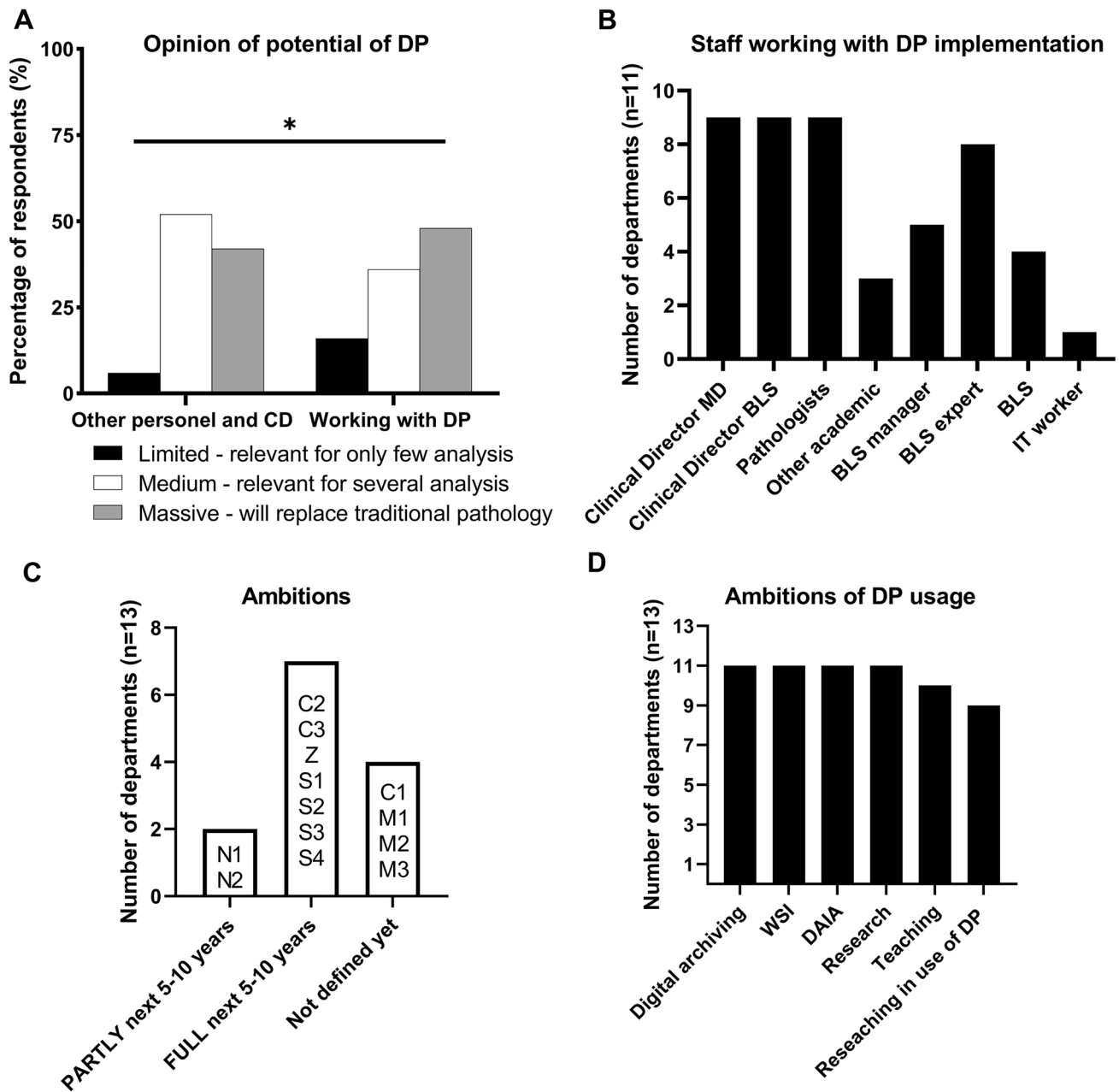


Fig. 1 **A** The difference ($p=0.02$) in opinions on the potential of DP based on personnel working with DP ($n=70$) versus personnel not working with DP and clinical directors ($n=161$). **B** Danish DP implementation was based on collaborations between professions in many departments (based on answers from management ($n=24$)). **C** There were variations in ambitions if the departments should be partly or fully digitalized within the next years (based on answers from management). Bar chart shows the extend of DP ambitions at 13 Danish

pathology departments (Letters represent the 5 Danish regions and the numbers the departments—see body text for abbreviations). **D** Not all Danish departments had yet fully defined, which workflows should be digitalized, however, most had ambitions of a wide usage (based on answers from the clinical directors). *DP* digital pathology, *CD* clinical directors, *MD* medical doctors, *BLS* biomedical laboratory scientists, *WSI* whole slide imaging, *DAIA* digitally assisted image analysis

69% (9/13), and various models were mentioned: XR, S360, S60, S210, and 2.0-HT. Only Region Z (8% (1/13)) used scanners from Leica (Leica Microsystems, Wetzlar, Germany). Three departments did not reply.

Software for Whole Slide Imaging

For whole slide imaging (WSI), 46% (6/13) of the departments used the Hamamatsu NDP viewer software (Hamamatsu

Future roles for staff in Digital Pathology

Management's opinion (%)

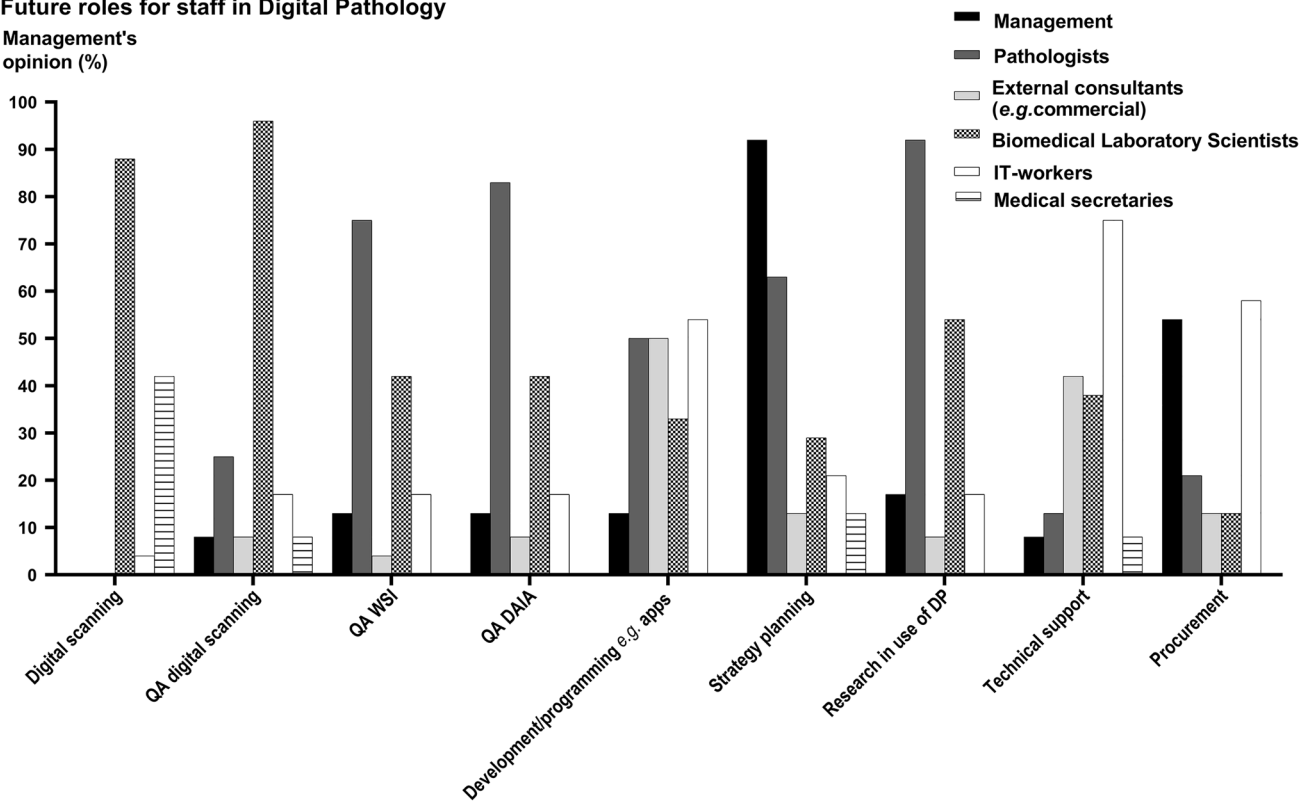


Fig. 2 Opinions on future work assignments according to professions. Based on answers from clinical directors for medical doctors (MD) ($n=5$) and for clinical directors of biomedical laboratory scientists

(BLS) ($n=9$) and middle BLS managers ($n=10$). *DP* digital pathology, *QA* quality assurance, *WSI* whole slide imaging, *DAIA* digitally assisted image analysis

Photonics, Hamamatsu City, Japan). Of these, one department also informed they used 3DHitech software (3DHitech, Budapest, Hungary) and software from Sectra Digital Pathology Solution (Sectra, Linköping, Sweden). In Region Z, they used VisionTek (Sakura Finetek, CA, USA) for WSI. One department specified they additionally used BD Focalpoint imaging system (BD Diagnostics, Burlington, NC, USA) for cytology. Six departments did not reply regarding WSI software.

Software for Digitally Assisted Image Analysis

For DAIA, 62% (8/13) of the departments applied the VIS software (Visiopharm, Hørsholm, Denmark), whereas the Region Z department used Tissue IA (Leica Microsystems, Wetzlar, Germany). Four departments did not reply regarding DAIA software.

Software were stored on local computers and/or on central servers. One respondent explained that the software was installed locally but APPs and licenses were installed on a regional server.

Servers and Storage

Of personnel working with the DP implementation process, 23% (12/52) found lack of server capacity challenging and one respondent qualitatively added that local networks at the hospital could not sustain the amount of data throughput needed when going digital.

An MD qualitatively added the high necessity of the international DICOM standards (Digital Imaging and Communications in Medicine). DICOM enables medical image files to be down scaled for digital archiving and exchange.

Other Hardware

An MD qualitatively stated that screen quality and screen settings like contrast and color have impact on standardization. In the questionnaire, some mentioned that other hardware had been bought to support DP such as screens (Barco display system (Barco, Kortrijk, Belgium) and EIZO Flex-Scan EV3237 (EIZO, Ishikawa, Japan)), hard-discs, laptops (Microsoft Surface Pro laptop (Microsoft, Redmond, WA,

USA)), and PCs (Lenovo Thinkstation (Lenovo, Beijing, China)).

Practical Digital Pathology Workflows in Danish Laboratories

Implementing DP may have technical and practical challenges; personnel working with DP implementation 58% (30/52) experienced challenges with the new DP workflows.

Digital Scanning

Of personnel working with DP ($n = 70$), the majority 46% (32/70) found that scanners had problems, like being too slow or too many breakdowns, while 29% (20/70) did not experience problems to a significant degree (25% (18/70) replied “don’t know”).

Only one Danish department scanned around 1600 slides weekly (largest department in Region S), two departments 400–600 slides, and the majority 62% (8/13) scanned 0–200 slides weekly (two departments did not answer). Four departments scanned both whole sections and tissue microarray, and five departments only whole sections (four departments did not answer).

Physical and Digital Archiving

Digital files were stored in a digital archive at eight departments (62%). One department only stored the digital files sometimes, and one had not started the digital archiving yet. Most departments (69% (9/13)) always archived physical glass slides after digital scanning. However, 90% (63/70) of personnel working with DP believed that the space for archiving glass slides will be strongly or moderately reduced in the future. Only 6% (4/70) did not believe DP will make significant reductions in glass storage.

Primary Diagnostics and Digital Pathology

Six departments (46%) used WSI every day for primary diagnostics or as a supplement to conventional light microscopy. One department used WSI occasionally once a week, another once monthly, and one department never used WSI for primary diagnostics (four departments did not answer). Of 37 MD working with DP, most (65%) believed that DP will reduce image quality, but only 17% believed that DP will actually impair primary diagnostics (see Fig. 3). Almost half (48%) believed that primary diagnostics will be more time consuming, while 43% believed it will not significantly change. Professions seem to agree that DP will reduce

physical storage, improve work flow and improve external collaborations (see Fig. 4). However, there were also discrepancies among professions, with most clinical directors believing DP will be faster (64%) and more precise (79%), but for MD the numbers were only 35% (faster) and 51% (more precise), see Fig. 4.

Personal Opinions and Experiences in Digital Pathology

How Personnel Experience Collaboration with the Local IT Department

Among personnel working with DP implementation, 27% (14/52) experienced technical problems with software or hardware (e.g., breakdowns, slow connections) and 23% lack of server capacity. Of all personnel working with DP ($n = 70$), 10% found the IT staff to solve problems effectively, 43% found they solve most problems, and only 6% found the IT staff rarely solve their problems and communication being difficult (41% did not answer).

Opinions on Challenges and Disadvantages in Digital Pathology

Of personnel working with the DP implementation process, 42% (22/52) perceived the implementation process challenging because of resistance/skepticism among fellow colleagues, and this perception was especially evident at one department in Region C (88% (7/8)). Opinions on disadvantages and challenges of DP from both clinical directors, pathologists/MD, and BLS are shown in Fig. 3. Furthermore, respondents added a comment if they had other disadvantages or challenges in mind (see second half of Table 3).

Opinions on Advantages in Digital Pathology

Opinions on advantages of DP from both clinical directors, pathologists/MD, and BLS are shown in Fig. 4. Furthermore, respondents added a comment if they had other advantages in mind; these are shown in first half of Table 3.

Knowledge and Education/Training in Digital Pathology

Five departments were already educating personnel in DP, another five departments had only just started educating personnel in DP, and three departments had not started but recognized the necessity. Of personnel implementing DP, 37% (19/52) found a lack of technical and IT knowledge

What challenges or disadvantages do you see in digital pathology? - state to what extent you agree

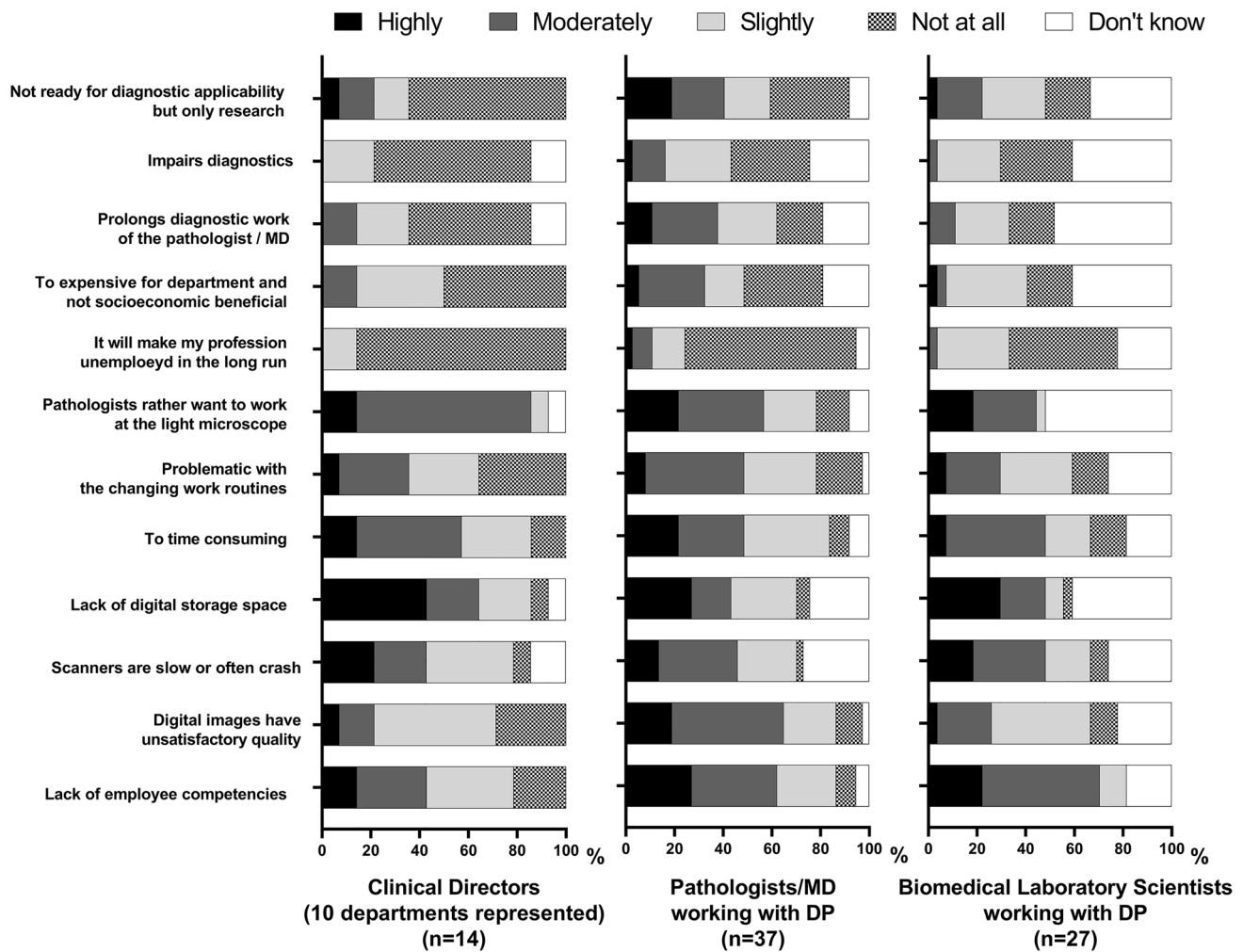


Fig. 3 Challenges and disadvantages in DP. The question was: “What challenges do you see in digital pathology—Indicate the extent to which you agree with the statements below”. The respondents then had to indicate the extent to which they agreed with a negative state-

ment, like: “Digital pathology is generally not ready for primary diagnostic applicability but only research”. DP digital pathology, MD medical doctor

at their department. Of personnel working with DP, 63% (44/70) highly or moderately agreed that skills in DP were lacking among colleagues, while only 24% (17/70) believed that skills in DP among colleagues were sufficient or almost sufficient.

Personnel working with DP were asked how prepared they felt about working with DP (Fig. 5A, B). They were also asked what type of training they have had (Fig. 5C, one MD replied “self-taught” (not in figure)). Of personnel having external courses ($n = 19$), they had been taught in digital scanning ($n = 8$); WSI ($n = 7$); DAIA ($n = 15$); and

in support of hardware/software ($n = 3$). Personnel having external courses were taught by representatives from a company 68% (13/19), courses at the BLS trade union (dbio) 21% (4/19), or other external experts on DP 53% (10/19). Others qualitatively mentioned conferences and visits to other digitalized departments.

Of all personnel from the survey, 48% (110/231) would like to receive training in DP. Of these, 35 were working with DP and 75 were not. Additionally, clinical directors and personnel working with DP were asked if they were interested in a national working group to exchange

What advantages do you see in digital pathology? - state to what extent you agree

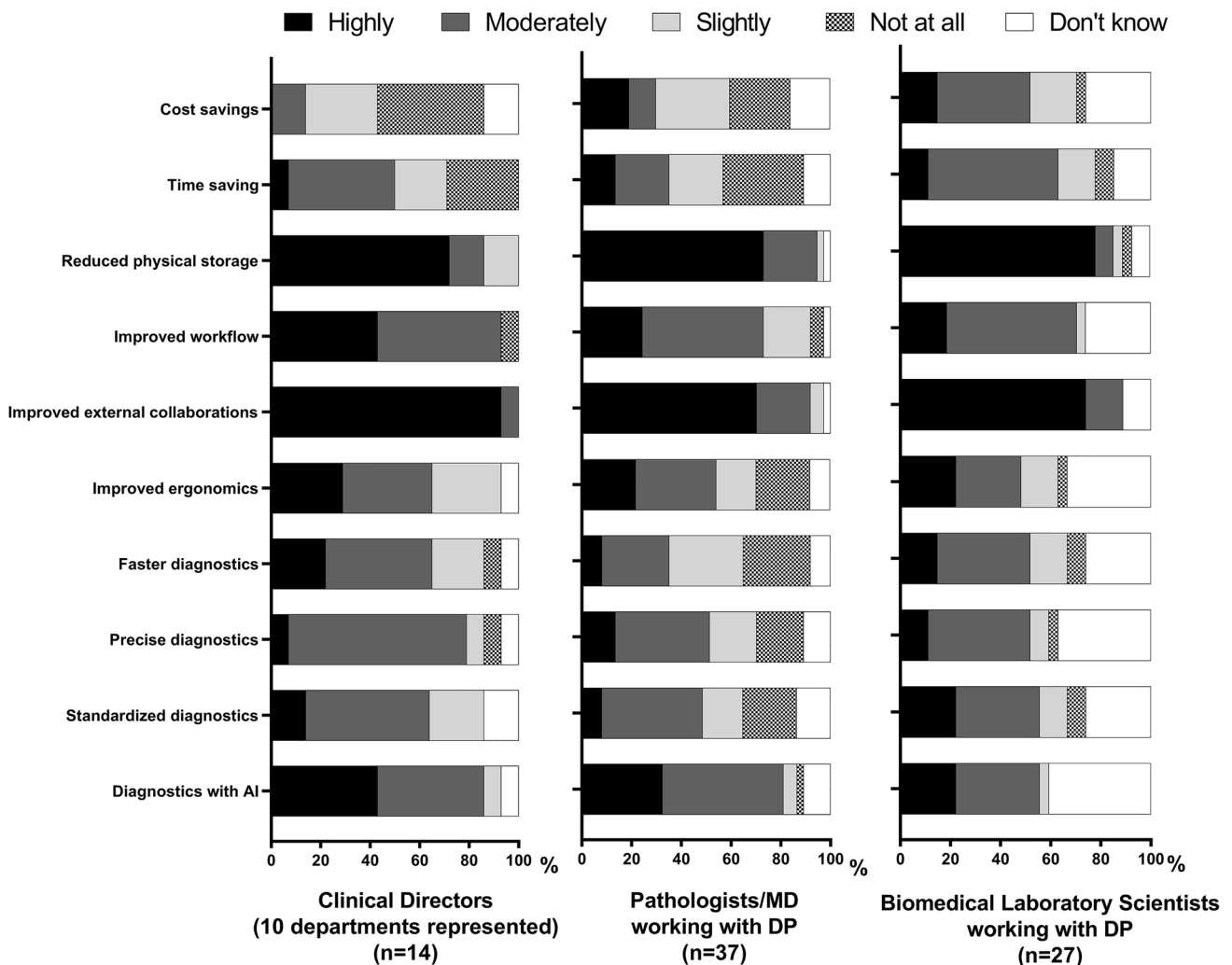


Fig. 4 Advantages in DP. The question was: “What benefits do you see in digital pathology? Indicate the extent to which you agree with the statements below”. The respondents then had to indicate the

extent to which they agreed with a positive statement, like: “Will save costs on the department in the future”. DP digital pathology, MD medical doctor, AI artificial intelligence

knowledge and experiences cross country with interdisciplinary colleagues working with DP (see results in Fig. 5D).

Interviews

Survey data on the implementation process were supported by interviews to gather more qualitative information and views on experiences of DP implementation. We interviewed four employees for a qualitative perspective on the implementation process: One medical clinical director (MCD), one clinical director of BLS (BLSCD), one chief pathologist (CP), and one BLS specialist in DP.

Management and Ambitions of Digital Pathology in Danish Pathology Departments

The Clinical Director for the Biomedical Laboratory Scientists

The clinical director for the biomedical laboratory scientists (BLSCD) has been part of DP working groups, steering committees, tender processes, and planning in the laboratories and has spent a quarter of working hours on DP implementation. BLSCD emphasized the scope of the large expenses of, e.g., scanners, screens, archiving of picture files, and image management systems. BLSCD was concerned about technology not being ready, e.g.: “It must be in DICOM format and many

Table 3 Qualitative comments taken from the questionnaire from respondents on their view on advantages and disadvantages/challenges when implementing digital pathology

| Subject | Advantages |
|--|---|
| | “I greet the new technology welcome, which I have worked with since 2010, and for the first time it has moved forward to an extent where the world has opened its eyes to see possibilities rather than limitations” |
| Flexibility | <p>“Possibility of flexible working hours, opportunity to answer tests during holidays and other absences”</p> <p>“Better work environment. Opportunity for workstation at home, especially in relation to cryosection diagnostics on late operating days”</p> |
| Education | <p>“Provides other opportunities in relation to teaching/training of medical doctors/ biomedical laboratory scientists/students. It becomes easier to find specimens for teaching and it is not necessary to take pictures of them. Several tools for marking”</p> <p>“Specific areas can be marked easily and precisely on virtual slides. Remote supervision possible”</p> <p>“Many students are possible as opposed to conferencing by a multi-armed microscope with limited spaces”</p> |
| Research | <p>“So far, it has only been good in research and teaching contexts”</p> <p>“Research collaborations with other countries in particular can take place more easily”</p> |
| Collaboration | <p>“Faster exchange of knowledge at all levels. Sharing of virtual slides between departments for second opinion. When pathology departments are physically far apart, it saves a lot of logistics and time by introducing digital pathology”</p> <p>“I see it as a HUGE advantage for the patients that they get the most skilled pathologists to look at the tissue—no matter where in the world they sit”</p> <p>“Can be used to operate satellite functions e.g. cryosection diagnostics”</p> <p>“Good tool for Multidisciplinary team (MDT) conferences”</p> <p>“Increased communication between the departments”</p> <p>“May strengthen the collaboration between the pathology departments, both regionally and nationally”</p> <p>“The joint regional initiatives have already resulted in far more collaboration across the Region and a better understanding of each department's terms. This may be a side benefit, but not insignificant at all!”</p> <p>“Time saving for communication with colleagues in the same department and between departments”</p> |
| No archiving of glass | <p>“Less risk of slides getting lost because they are filed incorrectly or delivered incorrectly</p> <p>“Time saving not to archive glass slides and not having to search for glass slides”</p> <p>“Older samples can be found quickly with easy [digital] access to e.g. ten archived images”</p> <p>“No glass slides must be sent to consultants, which is both time-saving and avoids glass slides being lost in relation to this”</p> <p>“This way we avoid sitting in the odor of glue/zylene from the glass slides”</p> |
| Standardize and improve quality | <p>“Digital pathology requires a lot of the pre-analytical/analytical procedure—so they will naturally be optimized/quality assured further”</p> <p>“Improving quality is always good! To ensure uniform quality/standardization, as other pathologists in the country must also be satisfied with the scanned glass slides”</p> <p>“Opportunity to standardize everything from tissue preparation to special dyes throughout the country (or at least in the region)”</p> <p>“Objectivization of e.g. Ki67, but there are not yet programs good enough for this”</p> |
| Technology | <p>“You can get a better overview of the specimen”</p> <p>“You can see several slides/stains at once”</p> <p>“You can do visual double staining at IHC”</p> <p>“Better opportunity for documentation of finds—'screenshot'”</p> <p>“Some good digital tools that may make microscopy easier—e.g. easier to find the same place in a specimen that is stained with several different stains, but which can now be assessed side by side”</p> <p>“Have just now introduced it on FISH analyzes where we can scan and count positive spots in tissues and cells”</p> <p>“In cytogenetics, we have Neon Metasystem, where we scan metaphases for karyotyping digitally”</p> |
| Artificial intelligence | <p>“Hopefully the opportunity to use AI for scanning the specimens beforehand and indicate which requisitions most likely contain malignancy”</p> <p>“AI supported risk-based patient assessment would be beneficial- after all, it is difficult to recruit pathologists”</p> |
| Health | <p>“Maybe we pathologists over time become myopic from sitting at the microscope? In addition, I have noticed that many of especially my older colleagues do not set their microscope according to Köhler, which causes one to be totally blinded by light from the microscope, but they do not notice it themselves! Is this over the years harmful to the vision? Is spectacle wear more frequent with pathologists than with other specialists? If there are negative consequences for the sense of sight by traditional light microscopy, can it then be prevented by the transition to digital pathology?”</p> |

Table 3 (continued)

| Subject | Disadvantages and Challenges |
|---|---|
| “I have not been presented to DP solutions yet, which makes sense to me in a daily diagnostic setting—neither on the quality, pace, nor financially. If it did, I would be optimistic” | |
| Need for standardize and improve quality | <p>“The quality of cutting is a challenge. At the light microscope, one can “adjust” between the layers if folds appear and therefore look at the entire tissue even though the thickness varies due to folds. In digital pathology, there must be no folds in the cut, as the scanner cannot distinguish between several layers. This possesses high requirements to the biomedical laboratory scientist at the microtome”</p> <p>“It is very important with good thin cuts, or digital pathology is unusable”</p> <p>“High requirements for uniform cut and staining quality”</p> <p>“We clearly have a challenge in terms of the quality of the scanned specimens. Scanning cannot be used for every type of specimen as resolution is too low/magnification too small.”</p> <p>“Some tissue will not, as a starting point, be suitable for digital pathology. e.g. bladder.”</p> <p>“Scanners not optimized for production flow, too much hands-on, long scanning time, scanning quality not at the level of a microscope, uncertainty about if everything on the glass slide is scanned”</p> <p>“I may well be worried that scanning quality may be good enough or else we have to spend a lot of time and resources on re-cuts to make the cut quality good enough for scanning. Do we have enough staff?”</p> <p>“To agree on incision thickness, staining methods, placement of biopsies in capsule/glass between departments”</p> <p>“In some easy cases e.g. seborrheic keratosis you can hardly carry the slide to the scanner before it is already conventionally diagnosed. Digital pathology does not make sense everywhere”</p> <p>“It may require standardized/unidirectional staining (protocols) for all pathology departments if scanned images are to be exchanged between departments”</p> <p>“The use of AI still depends on the capabilities of the operator behind the system. One cannot avoid human handling”</p> |
| Ergonomics/working conditions | <p>“Lack of flexibility regarding working hours for those who are scanning”</p> <p>“How do we ensure ergonomics? Lack of focus on ergonomic and risk of strain injuries”</p> <p>“Ergonomics for doctors not sufficiently developed, especially navigation tools such as mouse, touchpads, etc</p> <p>“The ergonomics of a modern microscope are good, and much better than controlling an image with a mouse, also an “ergonomic” mouse”</p> <p>“Speed too slow for digital microscopy due delays in image display, which prolongs microscopy time, which is tiring by hours of microscopy”</p> <p>“There will still be a need for microscopes and if for sharing then the risk off poor maintenance and incorrect settings will increase, and logistical problems with access”</p> |
| Technology | <p>“As far as I am aware, there is a big challenge in figuring out which technical solutions will be most optimal, which solutions can “talk to each other” also between departments, does the equipment become out of date to fast?”</p> <p>“Missing some technical possibilities, e.g. double breaking with filter”</p> <p>“The field of view on a screen is significantly lower than in the microscope.”</p> <p>“Before AI is developed and implemented, benefits are very small”</p> <p>“Problems with crashes of scanners and software/network problems”</p> |
| Staff | <p>“The staff’s negative attitude to change is a challenge.”</p> <p>“In addition to good education, a new culture must be created where old habits must go away.”</p> <p>“The work with glass and light microscopy works! It should not be completely replaced with on-screen images at any time.”</p> <p>“I see no significant benefits”</p> |
| Time | <p>“Digital pathology increases time from tissue preparation to diagnostics.”</p> <p>“Scanning takes a very long time and is labor intensive.”</p> <p>“Large time consumption for the person who first has to scan glass, after which the pathologist has to diagnose on a screen, compared to the doctor just quickly putting the glass slide in the microscope and making the diagnosis.”</p> <p>“Takes time to get implemented like all other new things, but quickly becomes a useful tool.”</p> <p>“Remember time to further education of staff”</p> <p>“It will take longer before there is a digital solution for cytology”</p> |

Table 3 (continued)

| Subject | Disadvantages and Challenges |
|--------------------------|---|
| Economy | <p>“Economy is the big obstacle”</p> <p>“Expensive to convert to DP with the purchase of necessary equipment. One could fear implementation with cheaper and inferior equipment that degrades diagnostic quality.”</p> <p>“Currently requires additional resources (both finances and staff) that are not available.”</p> <p>“The economy is running wild and those who have to pay are not able to, so you end up with half a solution—which gives more frustrations than gains.”</p> |
| Law and patient security | <p>“Lack of insight into patient safety and lack of clarity of legal aspects (e.g. vulnerability in the event of a IT crash or whether all tissue on the glass have been scanned and whether you as a doctor are responsible for details that could not be seen on the scanned slides, but which could have been seen by conventional microscopy. Also, a needed focus on patient data when storing and sharing scanned material”</p> <p>“There has been no professional analysis of specific issues that digital pathology may solve or may not solve”</p> |
| Strategy | <p>“There is no total perspective described and translated into an overall strategy”</p> <p>“A typical politically conditioned implementation process without satisfactory involvement of the user groups”</p> <p>“The development potential is large, but it is not quite ready for general diagnostics (e.g. speed for switching between the individual cases). So, there is a real need for development!”</p> <p>“I think the future really lies in blood and gene-analyses”</p> <p>“From the questionnaire, it looks like I am very negative about digital pathology and I would like to elaborate: I am concerned that we introduce a new technology before it is ready and will be inferior quality compared to the light microscope. Both in terms of quality in the image and in the speed at which one can switch between different magnifications. In that case, it will degrade both the quality and the quantity of our work”</p> |

scanners cannot deliver that at the moment.” and an intermediate solution may be to transfer the files subsequently. When asked about DP collaboration between the four hospitals in Region S: “... Executive Boards and the Region have assigned almost 5.5 million EUR to this project including the image management system, which has now been purchased. Now we start the tender process of scanners—the plan is we buy the same to all our hospitals—with for instance technical support and AI- solutions it is important they are aligned.” The BLSCD explained that Region S has been the leading region in the DP process in Denmark but also acknowledged that a lot was happening in Region C, M and N. The BLSCD added “In Region South, Mid and North, we agree that we want a new Pathology System working across regions.”

The Clinical Director for the Medical Doctors

The interviewed medical clinical director (MCD) expressed great potential in DP, and explained the department had ambitions to implement DP within the next five years: “You may ask: So, are we fully digitized in five years? I don’t think so.” On the question on requirements for being ready: “Economy, Implementation and Change Management. It is an enormous change management project. We must deliver to the same high quality. It must not depreciate. That is a requirement.” Asked about how DP implementation may

succeed, the MCD stated that “it is an absolute necessity that it comes from above as well, because it is a financial cost that no hospital can bear....we are part of a political system and our grants and finances come from above [the government].” The MCD, however, emphasized that DP implementation should not only be based on above political decisions but local professional expertise and local assessment will be significant to cater for patient safety and quality. The benefit of networking with other regions: The MCD stated “We will learn from the experiences they [Region S] make during the tender processes and implementation of DP.”

The Chief Pathologist

The CP expressed concerns on choosing the right IT system: “I absolutely believe you need to spend time finding the right company... A system that works instead of a system that works to a certain extent and cannot “talk” to one another.” The CP was concerned about the implementation process involving many stakeholders including politicians not having the professional knowledge about pathology. The CP stated “It is extremely difficult, because of the many stakeholders involved. Also, because suddenly some funds are allocated, and a director abruptly becomes eager to buy for instance some screens because it is not certain the money is there the following year [...] One cannot avoid the coming of DP, but

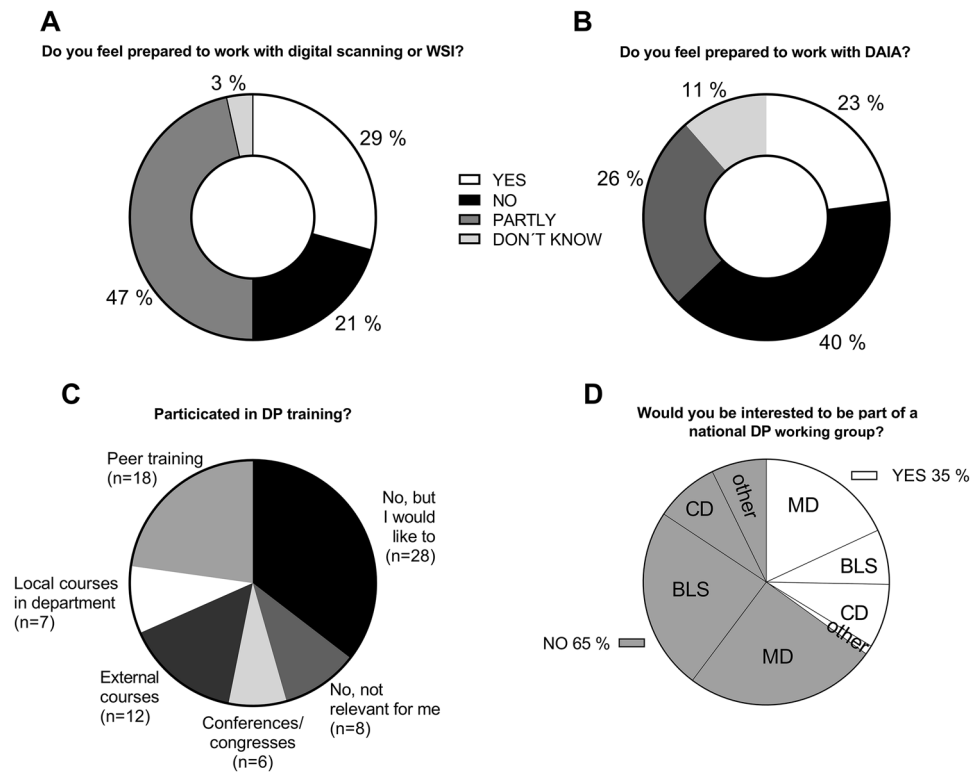


Fig. 5 **A** Asked the question: “Do you feel prepared to work with digital pathology- digital scanning for archiving and/or WSI?” (all working with DP, n=58). **B** Asked the question: “Do you feel prepared to work with digitally assisted image analysis?” (Includes respondents saying YES to working with DP and YES to departments ambition is to apply DAIA to primary diagnostics (n=35)). **C** Respondents working with DP (n=70) were asked “Have you participated in training/teaching in digital pathology?”. Multiple responses were possible. **D** Respondents

(n=84) working with DP (83%, 70/84) and all clinical directors (17%, 14/84) were asked if they were interested in being part of a national working group to exchange knowledge and experiences and 35% said yes, which may indicate a need (these were 8% CD, 18% MD, 7% BLS). DP digital pathology, MD medical doctors, BLS biomedical laboratory scientists, CD clinical directors, WSI whole slide imaging, DAIA digitally assisted image analysis

the concern is how DP will come,” and added “One should never be first mover on things like this [i.e., to implement DP].” The CP was familiar with the regional collaboration where his own region closely follows the DP process in Region S. “If it works [in Region S], we most likely do the same. That is our strategy for now.”

The BLS Specialist

The interviewed BLS specialist explained that there is a prestige in being the front runner in the DP implementation process, like in Region S, but believed that many employees may be concerned about the IT and afraid of doing something wrong. The BLS specialist also expressed: “If you asked the man on the floor I don’t think he has an opinion on this at all, but it is higher up in the ranks before you will find people that find this interesting [the DP implementation]. It is important how it is handled from the management. If it is just pushed down over people, then people cannot be bothered.”

Practical Workflows in the Laboratories

Digital Scanning

Working at one of the country’s major pathology departments, the BLSCD explained they already scanned all slides after microscopy and clinical reporting only for archiving purposes. The next step was scanning all slides “up front” for digital assessment, but they did not have technical prerequisites in place to scan 1600 slides a day and therefore were working on a robotic solution to archive the glass slides. The CP elaborates on this concern: “All scanners so far run really slow [...] and when it is urgent, and if all the slides have to be scanned, then I fear that it will add an extra day to our response times”. However, in some cases digital scanning may save time. The MCD explained “Instead of sending glass slides [with postal services], digital images are received, and a digital consultation performed – and I believe this may cut down on the [primary diagnostic]

response time. This is an important advantage where we already are really pressured [for time].”

Physical and Digital Archiving

The MCD believed that digital archiving may be time and cost effective for case assemblies with no archiving and no retrieving of physical slides. Also, the risk of mixing up slides is minimized, which increases patient safety: “We can store and archive images digitally and have them when I have to look at them in 10 years in a compact file format ... But we are not there yet.” However, the MCD, BLSCD, and CP also expressed concern regarding the extreme amounts of digital storage space for the scanned images and the costs of this.

General About DP and Workflow

Basically, the interviews underlined the diversity of views and experiences with DP observed from the surveys (see section “Survey: Personal opinions and experiences in Digital Pathology”). There was agreement on several advantages and disadvantages, but also discordance in statements were noticeable, like here, where the MCD states: “There may be many advantages. Flexibility for the pathologist to look at several slides concurrently...and to view digitally while simultaneously dictate using speech recognition. This I believe is streamlining the work process of the pathologist.” Whereas the CP finds the digital format challenging and not necessarily an alleviation: “It works fine to sit at a microscope. Almost your entire field of vision is made up of what you are looking at. When sitting at a screen, it is a very small part of your field of vision that you are actually using. I think it would be best if the [digital] pictures could be forwarded to a microscope.” Such diverse statements reflect a possible discordance in the managerial and end-user role and point of view.

Apart from the streamlining of the work of the pathologist, the MCD were aware that the already existing workflow in the actual pathology laboratories is not expected to change with DP, but only supplemented with an extra workload. The MCD elaborated: “It is important to understand that there is no quick-fix for a pathology diagnosis. It [DP] will prolong the process. [...] We must go through all the same steps from grossing and macroscopy to paraffin-embedding to sectioning on a microtome. Where are the financial gains? there are benefits—one of them is reducing risk of mix-up [of samples and patient ID].”

Discussion

This study was a glance on DP implementation in the early stages in Denmark from a personnel and management point of view. Please see Table 4 for take home messages. No departments in Denmark were fully digitalized in early 2020 but as part of a political and regional request, they were on the road. One region (South) was furthest and in tender processes preparing a fully digital future. In general, Danish employees were positive and saw many benefits in DP and acknowledge DP as part of the future, however, the concern was *how* this process would be handled because the DP technology does not possess a “one size fits all” in primary diagnostics.

Our overall response rate of 18% was comparable to another national study in Canada, where 17% of all registered pathologists responded via a link from an e-mail [9]. Other national surveys with different methods seem to have greater response rates like a UK national study with a response rate of 100% where the criteria was receiving one questionnaire per institution [5]; of note, our study also represented all pathology departments in Denmark.

Table 4 This study focused on the digital pathology (DP) implementation process in Denmark including end-user’s point of view and has brought about some essential take home messages to an implementation process. The term “end-users” includes relevant interdisciplinary professions working with DP. AI artificial intelligence

Change management is key for success

- Involve key DP end-users from interdisciplinary professions in DP implementation
- Continuous communicate about the DP implementation to end-users/personnel
- Be open about departmental DP strategies to personnel to avoid frustrations

Continuously measure DP performance and concerns among personnel

- E.g., by intradepartmental survey or interviews of end-users
- End-users may have relevant concerns which calls for solutions

DP training or educational programs must be considered

- Many end-users feel insecure and have limited experience in DP
- DP training or educational programs are sought after by personnel

Efforts should be made toward future-proof solutions

- Like, e.g., AI, scanners supporting DICOM-formats
- Involve key DP end-users from interdisciplinary professions
- Interdepartmental collaborations, like a national working group, increases knowledge base

A national working group including interdisciplinary professions is warranted

- Digital solutions must support future interdepartmental collaborations
 - The enormous financial burden warrants regional or national collaborations to optimize DP
-

Personnel in Danish Pathology Departments Working with Digital Pathology

The majority had less than 1-year DP work experience and spent less than a quarter of their day working with DP—possibly because DP is a new player in primary diagnostics in Denmark. Our study showed that the pathologists had the longest work experience in DP. DP has already been applied in research and education of MDs in Denmark since the end of the 00's and in primary diagnostics only in recent years [18–20]. That said, other countries, like Sweden and Canada, were early adopters and have been front runners in implementing WSI and DP in primary diagnostics since mid of the 00's [21–23] with an early success for frozen sections [24]. Digital technologies are not necessarily age dependent, and all ages may become comfortable with new technologies [25, 26], as our study also showed. DP in Denmark was neither a field domineered by any sex as may be expected in an IT-related field [27].

Management and Ambitions of Digital Pathology in Danish Pathology Departments

The general concern of personnel from both survey and interviews: It is not the when or if—but “*how*” DP will come about. According to Stathonikos et al. change management is key in the DP implementation process. In their experience, it was a success to closely involve and create ownership for all stakeholders [4]. This was also stressed out by our interviewed MCD.

It is noteworthy that almost half of the personal working with the implementation process of DP found it challenging that there was a lack of strategy at their departments. This was however not evident with personnel at the largest department in region S and might be explained with the fact that they were furthest in Denmark with DP implementation.

Collaborations in Denmark seemed more regionally based rather than nationally with regional hospitals, executive boards, and regional politicians. Our study points out the absolute necessity that certain decisions come from above, like regional collaborations, due to the enormous financial burden. Particularly, to ensure that the choice of digital solutions will support future interdepartmental collaborations.

Concerns about not having regional or national guidelines has also been described in the UK, where pathology departments are seeking clear guidelines and statements from national healthcare bodies to aid them in safe adoption of the digital reporting technology [5].

In our study, there was also a concern that local stakeholders were not heard, and important professional knowledge will be lost in the political processes. Embracing all

stakeholders may avoid another end-user frustration, such as the one Denmark recently experienced regarding a new Healthcare Platform (Sundhedsplatformen) [28, 29]. The importance of embracing the views of professionals (end-users) during a DP implementation process was highlighted in another survey from US-Canada. In this survey, they also expressed that DP was not ready for all primary diagnostics [30]. To compare and solve this matter, in Pittsburgh, USA, pathologists were continuously asked for feedback to optimize the DP implementation process: Feedback on slide scan time, WSI, case turnaround time, interface downtime, and diagnostic concordance - because the biggest challenges when adopting a fully digital workflow includes technical readiness, operational readiness, and cost. The need for dedicated personnel to deploy, validate, and maintain the digital pathology systems was also emphasized [31]. This was also described by Bellis et al.: “*Since pathologists represent the immediate “customers” of the technology, it is of prime importance to fully understand the reaction of pathologists toward this emerging technology [...] and an essential step toward better implementation of digital pathology in our practice through a thorough understanding of the needs, concerns, and expectations of digital pathology*” [9].

After our study, a new Danish National DP Working Group was established to follow and investigate developments in DP and actively support the digital transformation in Denmark through dialogue with interested pathology departments and externally through interdisciplinary collaboration with different professions. Their first meeting was in the end of 2020 (with co-author NM as chairman) [32].

Technological Equipment in Danish Laboratories

After tender processes, a Dutch fully digitalized laboratory selected Visiopharm VIS software, Hamamatsu scanners with Sectra PACS as the image management and workflow system [4]. In Denmark, most departments had bought Hamamatsu scanners with the NDP viewer for WSI, and Visiopharm was the preferred vendor for DAIA. After our interviews, the tender for an image management system in the Region of Southern Denmark was won by Sectra and the offering included options for this solution to the other four regions [33].

Only one vendor (Leica GT450 scanner) is currently capable of directly generating images in DICOM format, also noted by the interviewed BLSCD and a survey respondent. However, now in Region S, NDPI files from Hamamatsu scanners convert to DICOM immediately after scanning. Scanner slide sharing platforms exist and DICOM is still working with other WSI vendors at a connection level. Even variations of DICOM exists. So according to Region S experiences, waiting for DICOM formats to become a fully mature entity is not a prerequisite to establish a digital pathology network.

Practical Workflows in the Laboratories/Personal Opinions and Experiences

Our study includes personal experiences and opinions—both positive and negative—and other surveys have examined similar aspects [3, 5, 9, 14, 21, 30, 34, 35]. Our study differed by including mixed professions like MD, BLS, and clinical directors and both quantitative and qualitative methods. We found the view of different professions may vary accordingly, and also shows the nuance of a person seeming negative to DP at first but reveals that the negativity is more a concern if a new technology should be introduced before it is ready to sustain diagnostic quality and quantity. For the best outcome in an implementation process, it is of utmost importance to understand the concerns of the end-users—first then it is possible to solve the upcoming issues of the workflow, which at the end of the day is a matter of patient safety.

In our study, pathologists were concerned of DP prolonging the diagnostic workflow of the pathologist (39%) and workflow in general (48%)—this was also a concern of the interviewed informants. It is suggested that once pathology departments have navigated the DP learning curve, they will see improved diagnostic turnaround times and increased throughput from each pathologist including the need to break free from a hybrid workflow where pathologists move between glass slides and WSI [2, 4, 36]. Improving diagnostic turnaround time takes time, concerted effort, and cultural change, because not all departments find this improved efficiency immediately with varying efficiency among pathologists [37]. Baidoshvili et al. made a cost benefit analysis in favor of DP compared to conventional diagnostics [2]; however, scanning and potential rescanning processes was not stressed out in the study. As our interviewed MCD conclude, DP may be streamlining some of the work, but at the end of the day DP is an add-on in the laboratory workflow.

Good histology is a cornerstone for successful DP implementation. In our study, two-thirds of pathologists experienced that the digital image quality was unsatisfactory; however, only a fifth was actually concerned that DP would impair correct diagnostics. With this in mind, preanalytical cutting, mounting, and staining tissue sections are also part of adapting the laboratory workflow to DP, and not only the digitalization. However, if laboratories experience poor images this may also be resolved by existing key resources available like National Society of Histotechnologists Digital Pathology Certificate program or College of American Pathologists HQWSI Image Quality Improvement program. These entities may assist laboratories with improving the quality and consistency of their histology to the level required to support WSI diagnostics.

Knowledge and Education/Training in Digital Pathology

Only a third of the Danish employees working with DP were interested in being part of a national working group for exchanging knowledge and experiences cross country and relatively fewest BLS, despite their important knowledge in the laboratory flow [38].

According to our survey, there is not yet a standardized set-up for teaching DP in the Danish pathology departments. Many have not received any training and 20–40% reply that they do not feel professionally prepared in their work with DP. This was also the case in the UK, where two studies emphasized the urge for training programs among pathologists, because training would make them more likely to adopt and use the new digital imaging technology [5, 34]. Browning et al. also point out that regular access to digital cases facilitate familiarity with the digital diagnosis and platform; and the majority in their study agreed that training will make MD more likely to use DP [3]. Interestingly, Browning et al. found a growing interest among pathologists to learn DP in order to be able to report digitally during the COVID-19 pandemic outbreak due to reduced “contact” with glass slides and interpersonal contact using DP. In response to the survey, the British department even developed additional guidance in DP to the pathologists [39].

Follow up Information from Year 2022—Region of Southern Denmark

After our survey, the four departments of pathology in Region S have fully implemented DP for all histology specimens (authors NM and SH were part of the working group). The implementation process started in 2017 and the first specimens were diagnosed digitally in November 2020. In September 2021, the implementation process was completed at all four departments. The departments use Hamamatsu NanoZoomer scanners and the Sectra IMS solution. WSIs can freely be shared between our four departments. Glass slides are transferred from scanners to archiving and discarded after three weeks. This process is assisted by a new developed robot [40]. To save digital space, selected digital images are stored in full file formats for three months only, and the files are then compressed to be stored for 10 years. Tissue blocks are stored for minimum 50 years. At the beginning, the digital diagnostic response times became longer than with the conventional workflow. Now being accustomed to the new digital workflow, the response times for in-house patients are fairly the same as before, and even shorter for cases going externally. This by extending working hours and staff members for the scanning procedures. An evaluation of the implementation process

including a detailed assessment of specimen response time is undergoing.

Conclusion

To conclude, we found the predominance of personnel to be positively inclined toward the transition to DP and greeting the new technologies welcome in Danish pathology departments. However, there were also concerns. We recommend to continuously gather information from laboratory staff members about the preanalytical DP workflow and implementation as well as the analytical and postanalytical workflows. Incorporating departmental activities, like systematic internal surveys, interviews, or meetings, will assist in finding and troubleshoot challenges and errors to further optimize DP. Inclusion of staff members in DP implementation also keeps motivation high together with an educational focus on DP. Future proof DP solutions are crucial like enabling AI, DP crosstalk, and interdepartmental collaborations, which are the main benefits of DP. All this warrants great collaborations and communication within and across departments. Therefore, we also suggest establishing a national working group with relevant stakeholders, like an interdisciplinary DP team to provide knowledge for each other and for authorities—creating a foundation to make the right political and professional decisions to ensure patient safety, work efficiency, and best economical decisions at a national level.

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Code Availability Not applicable.

Declarations

Ethics Approval Approval from ethics committees was not required for either survey nor interviews.

Consent to Participate Written informed consent was obtained from informants before each interview.

Consent for Publication Written informed consent was obtained from informants before each interview.

Conflict of Interest The authors declare no conflict of interest.

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