BJR|Open https://doi.org/10.1259/bjro.20190012

Received: 08 February 2019 | Revised: 20 March 2019 | Accepted: 25 March 2019

Cite this article as:
Cannella R, Taibbi A, Pardo S, Lo Re G, La Grutta L, Bartolotta TV. Communicating with the hepatobiliary surgeon through structured report. *BJR Open* 2019; **1**: 20190012.

REVIEW ARTICLE

Communicating with the hepatobiliary surgeon through structured report

ROBERTO CANNELLA, MD, ADELE TAIBBI, MD, SALVATORE PARDO, MD, GIUSEPPE LO RE, MD, LUDOVICO LA GRUTTA, MD and TOMMASO VINCENZO BARTOLOTTA, MD

Section of Radiology, BiND, University Hospital "Paolo Giaccone", Via del Vespro, Palermo, Italy

Address correspondence to: Dr Roberto Cannella
E-mail: *rob.cannella89@gmail.com*

ABSTRACT

Communicating radiological findings to hepatobiliary surgeons is not an easy task due to the complexity of liver imaging, coexistence of multiple hepatic lesions and different surgical treatment options. Recently, the adoption and implementation of structured report in everyday clinical practice has been supported to achieve higher quality, more reproducibility in communication and closer adherence to current guidelines. In this review article, we will illustrate the main benefits, strengths and limitations of structured reporting, with particular attention on the advantages and challenges of structured template in the preoperative evaluation of cirrhotic and non-cirrhotic patients with focal liver lesions. Structured reporting may improve the preoperative evaluation, focusing on answering specific clinical questions that are requested by hepatobiliary surgeons in candidates to liver resection.

INTRODUCTION

Besides making the correct diagnosis, a clear and effective communication of imaging findings should be the main goal to achieve for the interpreting radiologist. Most of the physicians heavily rely on radiologic reports to plan patient's management and treatment. Thus, clear report of findings and impressions have significant clinical relevance. Traditional nonstructured reports are composed by free narrative text, with variability of information, terminology, and recommendations written by radiologists.[1] Subjective interpretation of free-text reports may result difficult for the referring physicians and often end up into a second radiological consult for clarifications.[1] Moreover, free-text reports may lack clinically relevant information that are essential for surgical plan.

In the setting of hepatobiliary surgery, one of the major objective for the abdominal radiologist interpreting liver study is to determine the eligibility for surgery in patients with malignant hepatic lesions. Reporting liver imaging is not an easy task. Reports are challenging given the possible presence of underlying chronic liver disease with multiple hepatic findings, coexistence of benign and malignant lesions, sequela of locoregional treatments, and complex imaging appearance which require analysis of many sequences and phases as well as comparison with prior studies. Moreover, radiologists are required to summarize the main findings according to several guidelines systems, such as Liver Imaging Reporting and Data System (LI-RADS) for assessing the lesion probability of being a hepatocellular carcinoma (HCC) in high-risk patients[2] or RECIST criteria to evaluate the treatment response in solid neoplasm after chemotherapy.[3]

Within this complexity, it is easy to omit relevant findings requested by hepatobiliary surgeons. Prior literature and scientific societies have introduced structured reports for many clinical circumstances. Radiological societies, including the Radiological Society of North America and Society of Abdominal Radiology, have recommended and support the spread of structured reports, publishing templates focused on clinical scenarios or specific diseases.[4,5] Websites (open.radreport.org) have been developed to share large number of templates in many languages. Despite these advancements, communicate imaging findings to hepatobiliary surgeons remains challenging for the radiologists.

The purpose of this article is therefore to illustrate the main benefits, challenges and caveats of structured reporting with particular attention to the preoperative hepatobiliary imaging evaluation, focusing on the potential advantages in the communication of findings in patients with malignant hepatic lesions rising in cirrhotic and non-cirrhotic livers.

THE NEW ERA OF STRUCTURED REPORT

The highest goal of structured report is to impact clinical care through a significant improvement in communication of imaging findings to the referring physicians. In recent years growing emphasis and evidences are supporting the implementation of structured reports in clinical practice to achieve a higher quality and reproducibility in the communication with clinicians.[6,7] Recent evidences showed that structured report is rapidly gaining popularity.[8,9] Up to 50% of radiology attendings working in United States academic centres have developed specific structured reports for the majority of the radiological exams.[8] In hepatobiliary imaging, structured report has demonstrated high compliance rates among radiologists, reported to be 96 and 88% for abdominal CT and MRI, respectively.[9]

Many strengths have been highlighted for routine use of structured report. Structured reports decrease the incidence of syntactic and grammatical errors which are encountered in 22–33% of conventional dictations.[10,11] A structured template drastically reduces the use of subjective terms for communicating the impressions, preventing interpretation ambiguities.[12,13] Terms such as "consistent with," "compatible with" or "may represent" have shown significantly different interpretations among radiologists and clinicians regarding the intended lever of certainty for imaging diagnosis.[14] In liver imaging, Corwin et al[15] reported that up to 16 different terms were adopted in nonstructured reports to describe the same lesions at risk of being HCC, which may have been more simply classified as LR-4 or LR-5 according to LI-RADS lexicon.[2] Several radiologists also remark a significant increase in workflow efficiency with overall reduction of dictation time.[16,17] In academic centres, the implementation of structured reports has been proposed for residents training. Inexperienced residents may benefit of templates to develop search patterns focusing on clinically relevant findings, and reduce revision rates or omission errors.[8,18] These templates may be adopted as checklists to ensure completeness of the final reading.[19] Lastly, structured report also facilitates retrospective data collection for research purposes.

Several studies have shown a higher degree of satisfaction and clarity of the referring physicians in structured templates compared to free-text reports.[7,20–24] The highest improvements were considered the readability, easier interpretation, increased details, adherences with current practical guidelines recommendations[7,25–27] and, most important, higher rates of management recommendations suggested from radiologist.[7,20]

There is not a unique structured report. The templates should be designed together with the referring physicians taking care of a distinct disease and focusing on answering specific clinical questions.[13] The creation and implementation of templates needs to follow a multistep approach, based on systematic evaluation of literature evidences, selection of target imaging studies, education of the radiology team, involvement of the expert referring clinicians, template drafting, and finally validation in everyday clinical practice.[9,28,29] Structured reports need to be dynamic over time, with constant implementation and updates taking into account the current evidences and guidelines as well as feedbacks form interpreting radiologists and referring physicians.[23,28–30]

Structured format, consistency and standard lexicon conforming to the current guidelines are the three main columns of structured reports.[16] Most of templates are organized in paragraphs including clinical history, technique, comparison, findings and impressions. Technique paragraph should briefly document the main phases/sequences acquired as well as the administration of intravenous contrast agent and presence of any adverse or allergic reaction. These technical findings may be even populated automatically by the dictation software. Comparison with prior imaging studies evaluating the target organs should be always reported. The "findings" section is usually organized in subheadings, divided by the specific relevant lesions or various imaged organs (or anatomic structures).[1] Each subheading may be construed by narrative format or by standardized text with checkboxes containing options for description of specific findings.[16] Impressions should be concise and remain narrative to allow the radiologist to link the findings in a unifying diagnosis when appropriate. This section should include answers to the clinical questions, unexpected concerning relevant findings as well as suggestions for further evaluations, follow up or treatment option according to specific guidelines.[16] Differential diagnosis may be provided in case of uncertain interpretation of the described observations.

The caveat is to adopt structured report when appropriate according to the clinical context. The systematic use of structured report should not prevent the radiologist to switch or customize the template with free-text for more complex or unusual cases in which the standard template will be insufficient for describing all the relevant information.[8] Templates should simplify and improve the radiology workflow, thus rigid and inefficient reports may need to be revised, deimplemented or abandoned if there are no advantages in specific clinical scenarios.

Of note, adopting the structured report should not prevent the radiologist from discussing relevant cases with the referring physicians in multidisciplinary meetings. Multidisciplinary evaluation is necessary to take into account also patient's comorbidities, other clinical exams, and tumour pathologic aggressiveness. Patients with liver disease and HCC are frequently assessed in interdisciplinary tumour board for management consensus and a comprehensive report facilitates the presenting radiologist to review the main findings. In our experience, a significant amount of cases scheduled for multidisciplinary evaluation consist of studies acquired at outside institutions in which there is a lack in description of relevant findings that may preclude surgical treatment. Thus, a further radiological review is requested in most cases in order to select candidates for surgical resection.[19]

In hepatobiliary imaging few authors have assessed and highlighted the effects of structured report for specific description of hepatic lesions.[12,15,31] In our experience, based on tertiary academic center for the treatment of liver diseases, we have introduced the structured report for several clinical applications on abdominal imaging, with promising feedback for the screening

Figure 1. Example of structured template of contrast-enhanced CT developed and proposed at our Institution for HCC screening in cirrhotic patients. HCC, hepatocellular carcinoma.

Clinical history: [age]-year-old [female/male] with cirrhosis.

Locoregional treatment: [none – TACE/RFTA in segment…].

Technique: CT of the abdomen and pelvis was performed. Images were obtained prior and following the uneventful administration of [volume] ml of [contrast type].

Comparison: CT dated [MM/DD/YY].

Findings

Liver morphology: [Cirrhosis].

Lesion #1: In the hepatic segment [segment number] there is a [dimension] cm observation (series [number], image [number]) showing [nonrim arterial phase hyperenhancement] and [washout – enhancing capsule] on portal venous and delayed phases. Threshold growth is [present – absent]. The lesion is classifiable as LI-RADS [classification].

Lesion #2: In the hepatic segment [segment number] there is a [dimension] cm observation (series [number], image [number]) showing [nonrim arterial phase hyperenhancement] and [washout – enhancing capsule] on portal venous and delayed phases. Threshold growth is [present – absent]. The lesion is classifiable as LI-RADS [classification].

Lesion #3: In the hepatic segment [segment number] there is a [dimension] cm observation (series [number], image [number]) showing [nonrim arterial phase hyperenhancement] and [washout – enhancing capsule] on portal venous and delayed phases. Threshold growth is [present – absent]. The lesion is classifiable as LI-RADS [classification].

Hepatic vessels: [patency – nontumoral thrombosis – tumor in vein] of [portal vein – hepatic vein].

Anatomical variants of hepatic vasculature: [none – present (describe)].

Bile duct: [non dilated – dilated].

Extra-hepatic findings: [none, splenomegaly, varices, ascites].

Other organs: [describe other findings].

Impression:

- Lesion #1: [dimension] cm observation in segment [number], classifiable as LI-RADS [classification].
- Lesion #2: [dimension] cm observation in segment [number], classifiable as LI-RADS [classification].
- Lesion #3: [dimension] cm observation in segment [number], classifiable as LI-RADS [classification].
- [patent – nontumoral thrombosis – tumor in vein] of [portal vein – hepatic vein].

and diagnosis of HCC, preoperative staging of colorectal liver metastasis and pancreatic ductal adenocarcinoma.

COMMUNICATION WITH HEPATOBILIARY SURGEONS IN CIRRHOTIC PATIENTS

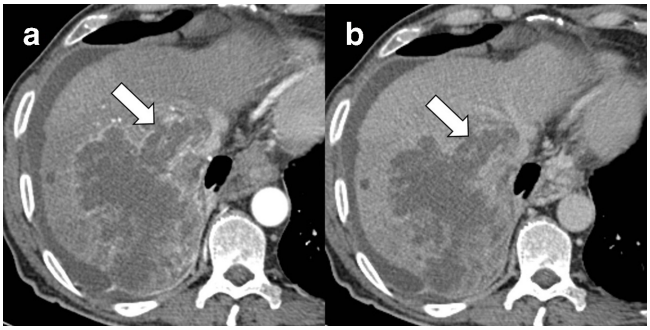
In cirrhotic patients, hepatocellular carcinoma is the most common liver malignancy, representing the leading cause of mortality in compensated cirrhosis.[32] According to the European Association for Study of Liver and the American Association for the Study of Liver Disease surgical resection is recommended for single HCC, even large lesions (*i.e.* diameter greater than 2 cm), when the hepatic function is preserved.[33–35] In multifocal HCC, patients may be eligible for surgery depending on lesions location within the liver parenchyma, performance status, comorbidities and liver function.[33]

Structured report in cirrhosis needs to clearly communicate the imaging diagnosis to the hepatobiliary surgeons. In our institution University of Palermo (Italy), structured reports have been routinely adopted for reporting liver lesions in cirrhosis or chronic liver disease (Figure 1). Each concerning lesion should be described individually, including location according to Couinaud segments, maximum diameter with series and image number in which the lesion is measured, presence of typical major imaging features of HCC (*i.e.* arterial phase hyperenhancement, washout, peripheral capsule and growth over time), as well as significant changes from prior exams.[35] When using LI-RADS for the non-invasive diagnosis of HCC, the final categorization should be reported individually for each untreated observation concerning for malignancy.[2] The spread of LI-RADS templates has been supported by the American College of Radiology website with sample reports and guidance for concise report according to LI-RADS recommendations.[36]

One of the major task of the radiologist is to communicate to hepatobiliary surgeons the presence of macroscopic vascular invasion of HCC or other non-HCC malignancies, which remains one of the main contraindication for surgery.[33,35] Findings suggestive of tumour in vein, such as enhancing thrombus (Figure 2), vessel expansion and restricted diffusion on MRI have to be scrutinized and described in each lesion.[37]

In cirrhotic patients, eligibility for surgery depends not only of tumour burden but also the stage of the chronic liver disease.[34] Indeed, the presence of radiological signs of portal hypertension may constitute a contraindication for surgery due to the increased risk of post-operative decompensation. Structured report should include a detailed description of liver morphology,

Figure 2. A 67-year-old male with HCV-related cirrhosis. Contrast-enhanced CT images on hepatic arterial (A) and portal venous phases (B) show a large hepatic mass with tumour in vein (arrows) of the right hepatic vein. The lesion is therefore considered unresectable. HCV, hepatitis C virus.



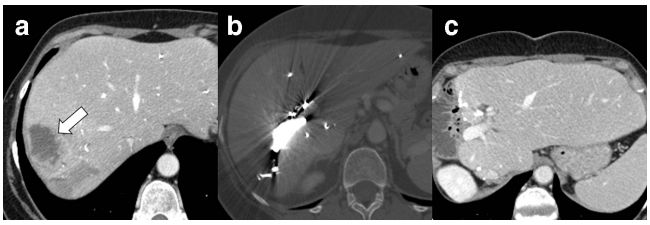
presence of oesophageal and/or gastric varices, recanalyzed para-umbilical vein, splenomegaly, and ascites.[35] Quantification of future liver remnant should also be reported when a major liver resection is planned to ensure sufficient future liver remnant (FLR).[35]

Radiological reports are crucial to determine organ allocation in patients referred to liver transplant. Eligibility to orthotopic liver transplant is based on the number and maximum diameter of lesions diagnosed as definitive HCC. Templates in candidates for orthotopic liver transplant may be integrated with the OPTN (Organ Procurement and Transplantation Network) classification, which assign exception points for transplant in patients with lesions that are unequivocally diagnosed as HCC by imaging in the United States.[38] Particularly, the OPTN encourages a structured summary at the end of the report, describing number, size, location and classification of lesions meeting the criteria for HCC.[38]

Finally, structured report may be also adopted to describe treatment response to locoregional treatment (*i.e.* TACE, transarterial chemoembolization; RFTA, radiofrequency thermal ablation), which is often performed as "bridge" to transplant. Reports should include individual description of treated lesions, with possible imaging features and dimension of recurrent/residual tumour.

Few recently published studies have investigated the relevance of structured report in cirrhosis.[12,15,31,39,40] Flusberg et al[12] demonstrated that structured templates using LI-RADS for diagnosis of HCC were significantly associated with higher frequency of reported LI-RADS category, description of major features of HCC as well as size and location of the observations. Poullos et al[31] analyzed the performance of structured report in patients with HCC eligible for orthotopic liver transplant. In that study, structured template was associated with significantly improved communication of imaging findings, OPTN class and eligibility for transplant. However, further studies will be necessary to validate proposed structured reports by radiological society in cirrhosis.

Figure 3. A 57-year-old female with intra hepatic cholangiocarcinoma. (A) Contrast-enhanced CT shows a rim-enhancing mass (arrow) in the right hepatic lobe. Patient underwent preoperative embolization of the right portal vein (B) to hypertrophy the left liver. Contrast-enhanced CT after resection (C) well demonstrates the hypertrophy of the remnant left liver.



COMMUNICATION WITH HEPATOBILIARY SURGEONS IN NON-CIRRHOTIC PATIENTS

In non-cirrhotic livers, metastases, especially from colorectal origin, are the most common malignant lesions. Hepatic metastases are the primary cause of mortality in patients with other abdominal neoplasms.[35] Although HCC may also arise in patients without evident risk factors for chronic liver disease, its diagnosis usually requires a histopathological confirmation. Another primary hepatic malignancy most commonly occurring in non-cirrhotic patients is intrahepatic mass-forming cholangiocarcinoma. Surgical resection of tumours limited to the liver remains the only potential curative treatment providing long survival rates.[41] Communicating the imaging findings to hepatobiliary surgeons should take into account the possible surgical treatment. Lesions in healthy liver are resected in a single-stage surgical procedure in the vast majority of cases,[42] with 7–10% of patients undergoing synchronous resection of the extra hepatic primary tumour and liver metastasectomy.[43] Major hepatic resection may be needed in patients that are otherwise considered unresectable and may require preliminary procedures (Figure 3) to hypertrophy the uninvolved liver.[42] Although normal liver parenchyma has the unique capability to regenerate, extended resections significantly increase the risk of postoperative hepatic failure if the future liver remnant volume is too small.[44]

In this context the structured report may be adopted to assess the major surgical concerns in candidates for liver resection. In our experience, we have proposed and implemented the structured reports for pre-operative staging of patients with colorectal liver metastasis on both contrast-enhanced CT (Figure 4) and MRI, with improvements in communication with hepatobiliary surgeons. The template should include all the surgically relevant anatomic factors needed to plane the resection, evaluate the extrahepatic disease, background liver parenchyma with FLR, and changes after neoadjuvant chemotherapy.[45]

The size and number of lesions, number of involved and uninvolved segments, as well as the relationship and degree of tumour contact with arterial and venous hepatic vessels should be accurately described.[35,45] Hepatic lesions should be individually described to maximize the chance of removing all macroscopic disease during operation.[35,46] Intrahepatic vascular involvement remains one of the major concern for hepatobiliary

Figure 4. Example of structured template of contrast-enhanced CT developed and proposed at our institution for preoperative evaluation of non-cirrhotic patients with colorectal liver metastasis.

Clinical history: [age]-year-old [female/male] with colorectal adenocarcinoma.

Chemotherapy: [none – number cycles of …].

Locoregional treatment: [none – resection of segment … – left/right hepatectomy].

Technique: CT of the abdomen and pelvis was performed. Images were obtained prior and following the uneventful administration of [volume] ml of [contrast type].

Comparison: CT dated [MM/DD/YY].

Findings

Liver morphology: [Normal – Dysmorphic liver - Cirrhosis].

Lesion #1: In the hepatic segment [segment number] there is a [dimension] cm lesion (series [number], image [number]) showing [hyperenhancement – rim enhancement – no enhancement] on hepatic arterial phase [with – without] washout on portal venous phase. The lesion is [increased in size – stable – decreased in size] compared to prior exam, previously measuring [dimension] cm. The lesion is [probably metastasis – indeterminate – probably benign].

Lesion #2: In the hepatic segment [segment number] there is a [dimension] cm lesion (series [number], image [number]) showing [hyperenhancement – rim enhancement – no enhancement] on hepatic arterial phase [with – without] washout on portal venous phase. The lesion is [increased in size – stable – decreased in size] compared to prior exam, previously measuring [dimension] cm. The lesion is [probably metastasis – indeterminate – probably benign].

Lesion #3: In the hepatic segment [segment number] there is a [dimension] cm lesion (series [number], image [number]) showing [hyperenhancement – rim enhancement - no enhancement] on hepatic arterial phase [with – without] washout on portal venous phase. The lesion is [increased in size – stable – decreased in size] compared to prior exam, previously measuring [dimension] cm. The lesion is [probably metastasis – indeterminate – probably benign].

Hepatic vessels: [patency – nontumoral thrombosis – tumor in vein] of [portal vein – hepatic vein].

Anatomical variants: [none – present (describe)].

Bile duct: [non dilated – dilated].

Hepatic volume: left lobe [measurement] ml; right lobe [measurement] ml.

Other organs: [describe other findings].

Impression:

- Lesion #1: [dimension] cm lesion in segment [number], [new – increased in size – stable – decreased in size] compared to prior exam.
- Lesion #2: [dimension] cm lesion in segment [number], [new – increased in size – stable – decreased in size] compared to prior exam.
- Lesion #3: [dimension] cm lesion in segment [number], [new – increased in size – stable – decreased in size] compared to prior exam.
- [patent – nontumoral thrombosis – tumor in vein] of [portal vein – hepatic vein].

surgeons. Vascular invasion of the main portal vein or hepatic artery often prevents tumour eradication.[46] Although the intrahepatic vascular tumour contact does not preclude the radical resection, it requires surgical excision of the whole liver parenchyma drained or perfused by the involved vessels. Optimal report should also provide clear description of anatomical biliary and vascular variants of potential surgical significance that may significantly influence the resectability or increase the risk of iatrogenic injuries during resection.

The presence of extrahepatic disease is another significant contraindication for liver resection. Extrahepatic lesions concerning for malignancy should be always carefully described in the structured report in both findings and impressions.[45] Size and locations of enlarged suspicious abdominal lymph nodes should be also reported.

Structured report should include the preoperative evaluation of future liver remnant which is the most important predictor of post-operative liver failure.[44,47] A minimal future liver volume greater than 20% is required to support post-resection hepatic function in major procedure in patients with healthy liver.[35,44] However, the minimal FLR cut-off is increased up to 30–40% in patients with steatosis, fibrosis or chemotherapy-related liver dysfunction, in order to minimize the risk of postoperative liver failure.[41,44,48] A total FLR smaller than 25% may represent a significant limitation for conventional resection and it represents one of the most frequent indication for preoperative portal vein embolization or two-stage hepatectomy.[41,42]

Up to 60% of patients receive neoadjuvant chemotherapy before resection of hepatic metastases,[49] thus comparison with prior exams, with description of size changes, evidences of treatment

response or stability of the disease need to be included in the structured reports.[3] Olthof et al[50] demonstrated that implementation of structured reporting improves the report quality and adherence to RECIST guidelines for assessing treatment response. Of note, in patients receiving neoadjuvant treatment attention should be made on possible liver confounders that are caused by chemotherapy-induced hepatotoxicity. Particularly, oxaliplatin treatment of colorectal metastasis has been associated with sinusoidal obstruction syndrome[51] and in some cases to the new appearance of focal nodular hyperplasia-like nodules.[52] Knowledge of the presence of sinusoidal obstruction syndrome is significantly relevant for the surgeons because it has been associated with reduced FRL hypertrophy after portal vein embolization and higher risk of post-operative hepatic failure.[53]

Although structured reporting is recommended by several societies for preoperative evaluation of focal liver lesions in non-cirrhotic liver, there is still lack of evidences supporting its value in the radiological literatures. Further studies will be necessary to demonstrate the added value of structured reporting in the preoperative evaluation of hepatic metastasis and primary liver tumours.

LIMITATIONS

Multiple limitations have also questioned the value of structured reporting in clinical practice. Unique reporting style among radiologists and lack of personalized diagnosis have been the main obstacles and resistances for the adoption of structured templates.[1,54] Indeed, structured reports may result useless and more time-consuming for interpreting complex cases on CT and/or MRI studies with limitations to the radiologists' freedom of dictations and expression.[1,54] Most importantly, structured reports are felt to obstacle customized report for patients' clinical background.

CONCLUSIONS

In conclusion, we illustrated the major strengths, advances and limitations of structured reporting in liver imaging focusing on communicating imaging findings to hepatobiliary surgeons for treatment of malignant liver lesions in cirrhotic and non-cirrhotic patients. Implementation of structured templates may improve the reports quality and completeness, focusing on answering relevant clinical question that are crucial for surgical planning.

REFERENCES

1. Ganeshan D, Duong P-AT, Probyn L, Lenchik L, McArthur TA, Retrouvey M, et al. Structured reporting in radiology. *Acad Radiol* 2018; **25**: 66–73. doi: https://doi.org/10.1016/j.acra.2017.08.005
2. American College of Radiology. Liver imaging reporting and data system.. Available from: https://www.acr.org/Clinical-Resources/Reporting-and-Data-Systems/LI-RADS [Accessed on February 2019].
3. Eisenhauer EA, Therasse P, Bogaerts J, Schwartz LH, Sargent D, Ford R, et al. New response evaluation criteria in solid tumours: revised RECIST guideline (version 1.1. *Eur J Cancer* 2009; **45**: 228–47. doi: https://doi.org/10.1016/j.ejca.2008.10.026
4. . Radiological Society of North America website. RSNA RadReport Template Library.. Available from: www.radreport. org. 2018. Accessed on February 2019..
5. Society of Abdominal Radiology. Disease-Focused Panels.. Available from: https://www.abdominalradiology.org/page/DFP [Accessed on February 2019].
6. Faggioni L, Coppola F, Ferrari R, Neri E, Regge D. Usage of structured reporting in radiological practice: results from an Italian online survey. *Eur Radiol* 2017; **27**: 1934–43. doi: https://doi.org/10.1007/s00330-016-4553-6
7. Heye T, Gysin V, Boll DT, Merkle EM. Journal Club: structured reporting: the voice of The customer in an ongoing debate about the future of radiology reporting. *AJR Am J Roentgenol* 2018; **211**: 964–70. doi: https://doi.org/10.2214/AJR.18.19714
8. Powell DK, Silberzweig JE. State of structured reporting in radiology, a survey. *Acad Radiol* 2015; **22**: 226–33. doi: https://doi.org/10.1016/j.acra.2014.08.014
9. Goldberg-Stein S, Walter WR, Amis ES, Scheinfeld MH. Implementing a structured reporting initiative using a collaborative multistep approach. *Curr Probl Diagn Radiol* 2017; **46**: 295–9. doi: https://doi.org/10.1067/j.cpradiol.2016.12.004
10. Quint LE, Quint DJ, Myles JD. Frequency and spectrum of errors in final radiology reports generated with automatic speech recognition technology. *J Am Coll Radiol* 2008; **5**: 1196–9. doi: https://doi.org/10.1016/j.jacr.2008.07.005
11. Hawkins CM, Hall S, Zhang B, Towbin AJ. Creation and implementation of department-wide structured reports: an analysis of the impact on error rate in radiology reports. *J Digit Imaging* 2014; **27**: 581–7. doi: https://doi.org/10.1007/s10278-014-9699-7
12. Flusberg M, Ganeles J, Ekinci T, Goldberg-Stein S, Paroder V, Kobi M, et al. Impact of a structured report template on the quality of CT and MRI reports for hepatocellular carcinoma diagnosis. *J Am Coll Radiol* 2017; **14**: 1206–11. doi: https://doi.org/10.1016/j.jacr.2017.02.050
13. European Society of radiology (ESR). ESR paper on structured reporting in radiology. *Insights Imaging* 2018; **9**: 1–7.
14. Lee B, Whitehead MT. Radiology reports: what you think you're saying and what they think you're saying. *Curr Probl Diagn Radiol* 2017; **46**: 186–95. doi: https://doi.org/10.1067/j.cpradiol.2016.11.005
15. Corwin MT, Lee AY, Fananapazir G, Loehfelm TW, Sarkar S, Sirlin CB. Nonstandardized terminology to describe focal liver lesions in patients at risk for hepatocellular carcinoma: implications regarding clinical communication. *AJR Am J Roentgenol* 2018; **210**: 85–90. doi: https://doi.org/10.2214/AJR.17.18416
16. Manoonchai N, Kaewlai R, Wibulpolprasert A, Boonpramarn U, Tohmee A, Phongkitkarun S. Satisfaction of imaging report rendered in emergency setting: a survey of radiology and referring physicians. *Acad Radiol* 2015; **22**: 760–70. doi: https://doi.org/10.1016/j.acra.2015.01.006
17. Hanna TN, Shekhani H, Maddu K, Zhang C, Chen Z, Johnson J-O. Structured report compliance: effect on audio dictation time, report length, and total radiologist study time. *Emerg Radiol* 2016; **23**: 449–53. doi: https://doi.org/10.1007/s10140-016-1418-x
18. Johnson TF, Brinjikji W, Doolittle DA, Nagelschneider AA, Welch BT, Kotsenas AL. Structured head and neck CT angiography reporting reduces resident revision rates.

Curr Probl Diagn Radiol 2018; **0188**: S0363–3110pii:.

19. Marcal LP, Fox PS, Evans DB, Fleming JB, Varadhachary GR, Katz MH, et al. Analysis of free-form radiology dictations for completeness and clarity for pancreatic cancer staging. *Abdom Imaging* 2015; **40**: 2391–7. doi: https://doi.org/10.1007/s00261-015-0420-1
20. Nguyen Q, Sarwar A, Luo M, Berkowitz S, Ahmed M, Brook OR. Structured reporting of IR procedures: effect on report compliance, accuracy, and satisfaction. *J Vasc Interv Radiol* 2018; **29**: 345–52. doi: https://doi.org/10.1016/j.jvir.2017.10.016
21. Sabel BO, Plum JL, Kneidinger N, Leuschner G, Koletzko L, Raziorrouh B, et al. Structured reporting of CT examinations in acute pulmonary embolism. *J Cardiovasc Comput Tomogr* 2017; **11**: 188–95. doi: https://doi.org/10.1016/j.jcct.2017.02.008
22. Nörenberg D, Sommer WH, Thasler W, D'Haese J, Rentsch M, Kolben T, et al. Structured reporting of rectal magnetic resonance imaging in suspected primary rectal cancer: potential benefits for surgical planning and interdisciplinary communication. *Invest Radiol* 2017; **52**: 232–9. doi: https://doi.org/10.1097/RLI.0000000000000336
23. Magnetta MJ, Donovan AL, Jacobs BL, Davies BJ, Furlan A. Evidence-based reporting: a method to optimize prostate MRI communications with referring physicians. *AJR Am J Roentgenol* 2018; **210**: 108–12. doi: https://doi.org/10.2214/AJR.17.18260
24. Schwartz LH, Panicek DM, Berk AR, Li Y, Hricak H. Improving communication of diagnostic radiology findings through structured reporting. *Radiology* 2011; **260**: 174–81. doi: https://doi.org/10.1148/radiol.11101913
25. Griffin AS, Mitsky J, Rawal U, Bronner AJ, Tessler FN, Hoang JK. Improved quality of thyroid ultrasound reports after implementation of the ACR thyroid imaging reporting and data system nodule lexicon and risk stratification system. *J Am Coll Radiol* 2018; **15**: 743–8. doi: https://doi.org/10.1016/j.jacr.2018.01.024
26. Buckley BW, Daly L, Allen GN, Ridge CA. Recall of structured radiology reports is significantly superior to that of unstructured reports. *Br J Radiol* 2018; **11**: 20170670. doi: https://doi.org/10.1259/bjr.20170670
27. Marcovici PA, Taylor GA. Journal Club: structured radiology reports are more complete and more effective than unstructured reports. *AJR Am J Roentgenol* 2014; **203**: 1265–71. doi: https://doi.org/10.2214/AJR.14.12636
28. Larson DB, Towbin AJ, Pryor RM, Donnelly LF. Improving consistency in radiology reporting through the use of department-wide standardized structured reporting. *Radiology* 2013; **267**: 240–50. doi: https://doi.org/10.1148/radiol.12121502
29. Larson DB. Strategies for implementing a standardized structured radiology reporting program. *Radiographics* 2018; **38**: 1705–16. doi: https://doi.org/10.1148/rg.2018180040
30. Pinto dos Santos D, Hempel J-M, Mildenberger P, Klöckner R, Persigehl T. Structured reporting in clinical routine. *Fortschr Röntgenstr* 2019; **191**: 33–9. doi: https://doi.org/10.1055/a-0636-3851
31. Poullos PD, Tseng JJ, Melcher ML, Concepcion W, Loening AM, Rosenberg J, et al. Structured reporting of multiphasic CT for hepatocellular carcinoma: effect on staging and suitability for transplant. *AJR Am J Roentgenol* 2018; **210**: 766–74. doi: https://doi.org/10.2214/AJR.17.18725
32. Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, et al. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer* 2015; **136**: E359–E386. doi: https://doi.org/10.1002/ijc.29210
33. Galle PR, Forner A, Llovet JM, Mazzaferro V, Piscaglia F, Raoul J-L, et al. EASL clinical practice guidelines: management of hepatocellular carcinoma. *J Hepatol* 2018; **69**: 182–236. doi: https://doi.org/10.1016/j.jhep.2018.03.019
34. Marrero JA, Kulik LM, Sirlin CB, Zhu AX, Finn RS, Abecassis MM, et al. Diagnosis, staging, and management of hepatocellular carcinoma: 2018 practice guidance by the American Association for the study of liver diseases. *Hepatology* 2018; **68**: 723–50. doi: https://doi.org/10.1002/hep.29913
35. Shin DS, Ingraham CR, Dighe MK, Wang C, Vaidya S, Moshiri M, et al. Surgical resection of a malignant liver lesion: what the surgeon wants the radiologist to know. *AJR Am J Roentgenol* 2014; **203**: W21–W33. doi: https://doi.org/10.2214/AJR.13.11701
36. Chernyak V, Fowler KJ, Kamaya A, Kielar AZ, Elsayes KM, Bashir MR, et al. LI-RADS) version 2018: imaging of hepatocellular carcinoma in at-risk patients. *Radiology* 2018; **289**: 816–30.
37. Cannella R, Fowler KJ, Borhani AA, Minervini MI, Heller M, Furlan A. Common pitfalls when using the liver imaging reporting and data system (LI-RADS): lessons learned from a multi-year experience. *Abdom Radiol* 2019; **44**: 43–53. doi: https://doi.org/10.1007/s00261-018-1720-z
38. Wald C, Russo MW, Heimbach JK, Hussain HK, Pomfret EA, Bruix J. New OPTN/UNOS policy for liver transplant allocation: standardization of liver imaging, diagnosis, classification, and reporting of hepatocellular carcinoma. *Radiology* 2013; **266**: 376–82. doi: https://doi.org/10.1148/radiol.12121698
39. Clark TJ, McNeeley MF, Maki JH. Design and implementation of handheld and desktop software for the structured reporting of hepatic masses using the LI-RADS schema. *Acad Radiol* 2014; **21**: 491–506. doi: https://doi.org/10.1016/j.acra.2013.12.014
40. Pinto dos Santos D, Arnhold G, Mildenberger P, Düber C, Kloeckner R. Guidelines regarding §16 of the German transplantation act – initial experiences with structured reporting. *Fortschr Röntgenstr* 2017; **189**: 1145–51. doi: https://doi.org/10.1055/s-0043-118129
41. Bertens KA, Hawel J, Lung K, Buac S, Pineda-Solis K, Hernandez-Alejandro R. ALPPS: challenging the concept of unresectability--a systematic review. *Int J Surg* 2015; **13**: 280–7. doi: https://doi.org/10.1016/j.ijsu.2014.12.008
42. Torzilli G, Adam R, Viganò L, Imai K, Goransky J, Fontana A, et al. Surgery of colorectal liver metastases: pushing the limits. *Liver Cancer* 2017; **6**: 80–9. doi: https://doi.org/10.1159/000449495
43. Idrees JJ, Bagante F, Gani F, Rosinski BF, Chen Q, Merath K, et al. Population level outcomes and costs of single stage colon and liver resection versus conventional two-stage approach for the resection of metastatic colorectal cancer. *HPB* 2019; **21**: 456–64pii: S1365-182X. doi: https://doi.org/10.1016/j.hpb.2018.08.007
44. Khan AS, Garcia-Aroz S, Ansari MA, Atiq SM, Senter-Zapata M, Fowler K, et al. Assessment and optimization of liver volume before major hepatic resection: current guidelines and a narrative review. *Int J Surg* 2018; **52**: 74–81. doi: https://doi.org/10.1016/j.ijsu.2018.01.042
45. Zerial M, Lorenzin D, Risaliti A, Zuiani C, Girometti R. Abdominal cross-sectional imaging of the associating liver partition and portal vein ligation for staged hepatectomy procedure. *World J Hepatol* 2017; **9**: 733–45. doi: https://doi.org/10.4254/wjh.v9.i16.733
46. Frankel TL, Gian RK, Jarnagin WR. Preoperative imaging for hepatic resection of colorectal cancer metastasis. *J Gastrointest Oncol* 2012; **3**: 11–18. doi: https://doi.org/10.3978/j.issn.2078-6891.2012.002
47. Schadde E, Raptis DA, Schnitzbauer AA, Ardiles V, Tschuor C, Lesurtel M,

et al. Prediction of mortality after ALPPS Stage-1: an analysis of 320 patients from the International ALPPS registry. *Ann Surg* 2015; **262**: 780–5. doi: https://doi.org/10.1097/SLA.0000000000001450

48. Shindoh J, Tzeng C-WD, Aloia TA, Curley SA, Zimmitti G, Wei SH, et al. Optimal future liver remnant in patients treated with extensive preoperative chemotherapy for colorectal liver metastases. *Ann Surg Oncol* 2013; **20**: 2493–500. doi: https://doi.org/10.1245/s10434-012-2864-7
49. Regimbeau JM, Cosse C, Kaiser G, Hubert C, Laurent C, Lapointe R, et al. Feasibility, safety and efficacy of two-stage hepatectomy for bilobar liver metastases of colorectal cancer: a LiverMetSurvey analysis. *HPB* 2017; **19**: 396–405. doi: https://doi.org/10.1016/j.hpb.2017.01.008
50. Olthof AW, Borstlap J, Roeloffzen WW, Callenbach PMC, van Ooijen PMA. Improvement of radiology reporting in a clinical cancer network: impact of an optimised multidisciplinary workflow. *Eur Radiol* 2018; **28**: 4274–80. doi: https://doi.org/10.1007/s00330-018-5427-x
51. Brancatelli G, Furlan A, Calandra A, Dioguardi Burgio M. Hepatic sinusoidal dilatation. *Abdom Radiol* 2018; **43**: 2011–22(NY). doi: https://doi.org/10.1007/s00261-018-1465-8
52. Furlan A, Brancatelli G, Dioguardi Burgio M, Grazioli L, Lee JM, Murmura E, et al. Focal nodular hyperplasia after treatment with oxaliplatin: a Multiinstitutional series of cases diagnosed at MRI. *AJR Am J Roentgenol* 2018; **210**: 775–9. doi: https://doi.org/10.2214/AJR.17.18867
53. Narita M, Oussoultzoglou E, Chenard M-P, Rosso E, Casnedi S, Pessaux P, et al. Sinusoidal obstruction syndrome compromises liver regeneration in patients undergoing two-stage hepatectomy with portal vein embolization. *Surg Today* 2011; **41**: 7–17. doi: https://doi.org/10.1007/s00595-010-4414-x
54. Tublin ME, Deible CR, Shrestha RB. The radiology report version 2.0. *J Am Coll Radiol* 2015; **12**: 217–9. doi: https://doi.org/10.1016/j.jacr.2014.04.014