Original Research Article

Data mining procedural reports of percutaneous interventions in dialysis access for quality assurance programs

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Abstract

Purpose: Ongoing quality assessment of dialysis access interventions is critical in the care of hemodialysis-dependent patients. The objective of this study was to mine data from interventional radiology (IR) reports of dialysis access interventions to determine if these reports contain the data necessary to retrospectively calculate quality outcome metrics required to support quality assurance (QA) programs.

Methods: A retrospective analysis was conducted of IR reports created at the institution between May 28, 2019 and October 16, 2020. Radiology reports pertaining to percutaneous image-guided management of thrombosed or dysfunctional hemodialysis circuits were included. Reports that only described diagnostic intervention(s) were excluded. Relevant reports were manually annotated according to a checklist of items derived from published reporting standards to determine whether reports contained the data necessary to retrospectively calculate quality outcome metrics, such as postintervention primary patency (PiPP) and postintervention lesion patency (PiLP).

Results: A total of 130 reports describing 78 patients were included in the analysis. Documentation of items derived from published reporting standards for dialysis fistulogram and interventions ranged from 28.5% to 100%. Only 18.5% and 15.4% of radiology reports were independently sufficient to calculate PiPP and PiLP, respectively.

Conclusion: Few reports were independently sufficient to retrospectively calculate quality outcome metrics, PiPP and PiLP. Results of this study suggest the need for greater standardization in reporting practices. Standardized reporting has the potential to improve communication, promote adherence to guidelines, and provide data for quality improvement projects to optimize patient care.

Keywords: Diagnostic imaging; patient safety; health information technology; quality improvement; hemodialysis

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Introduction

Since 1991, the Standards of Practice Committee of the Society of Interventional Radiology (SIR) has published numerous practice guidelines for image-guided procedures (1-5). This work not only highlights the importance of standardizing technical aspects of interventional procedures but also emphasizes the critical role of quality improvement in ensuring continued competence. Steele et al. described a systematic approach to quality improvement programs in interventional radiology (IR) consisting of both quality assurance (QA) and continuous quality improvement (CQI) activities (6). QA activities focus on quantifying the frequency of low-quality events, such as complications, compared to an agreed-upon quality threshold or metric; CQI activities seek to decrease waste and limit variation in the provision of care (6,7). In medicine, there are two types of waste: 1) quality waste, which refers to when resources are expended and the effort fails to produce the desired outcome, and 2) productivity waste, which refers to when more resources than necessary are used to achieve an outcome (6).

The overall objective of QA activities is to provide feedback mechanisms to improve the delivery of healthcare at an institutional level. If a department or individual falls below an acceptable minimal standard of performance, corrective steps, such as continuing medical education or a CQI project, can be taken. However, the most challenging part of most QA programs is access to data (8). Compared to most modern industries, healthcare severely lacks an adequate data infrastructure that enables the efficient retrospective evaluation of quality metrics. This means much of the data collection and analysis must be performed manually from procedural reports which often consist of unstructured prose. This inability to easily access the necessary data to support evaluation is exacerbated by the reality that many IR-groups, with the exception of large academic programs, lack the administrative support for robust QA activities, making the issue of capturing quality metrics even more challenging. The recent focus on structured reporting within IR may provide an opportunity for quality improvement programs to leverage the data contained in reports to generate quality metrics. Standardized reports have been shown to have several advantages in facilitating communication and documentation of procedural indications, clinical histories, techniques, equipment, and important findings (9).

One area of IR in which ongoing quality assessment and improvement practices are critical is in caring for hemodialysis-dependent patients. Well-functioning vascular access is vital in providing care to these patients. International quality improvement guidelines for percutaneous image-guided management of thrombosed or dysfunctional hemodialysis circuits, published by the SIR Standards of Practice Committee, suggest that outcome measurement thresholds should be used in ongoing quality improvement programs (1). The SIR Standards of Practice Committee defines a threshold as “a specific level of an indicator that, when reached or crossed, should prompt a review of departmental policies and procedures” (1). One example of an outcome metric is postintervention primary patency (PiPP), defined as the interval of uninterrupted patency between two consecutive vascular access interventions at any site within a dialysis circuit (1,10). In considering the management of an arteriovenous fistula with angioplasty, guidelines suggest PiPP

threshold rates of 74%, 54%, and 32% at three months, six months, and 12 months, respectively (1). Another example of an outcome metric is postintervention lesion patency (PiLP), defined as the interval of uninterrupted patency between two consecutive vascular access interventions at or adjacent to a lesion site (10). If a cohort of patients does not meet guideline thresholds, a multidisciplinary review of vascular access management should be undertaken to understand the root causes and propose solutions.

The objective of this study was to mine data from IR reports of dialysis access interventions to determine whether radiology reports are independently sufficient for the calculation of outcome measure thresholds, such as PiPP and PiLP rates. To the authors' knowledge, this is the first study of its kind.

Methods

Setting and population

This retrospective study was approved by the Hamilton Integrated Research Ethics Board (HiREB), and the requirement for informed consent was waived. A retrospective analysis of radiology reports created from May 28, 2019 to October 16, 2020 was conducted at the tertiary care centre. Reports pertaining to percutaneous image-guided management of thrombosed or dysfunctional hemodialysis circuits were included. Radiology reports that only described diagnostic intervention(s) were excluded.

Cohort identification

All radiology reports were identified and extracted from Picture Archiving and Communication System (PACS). All examinations were anonymized in a HiREB compliant manner. The initial data set was filtered by relevant IR procedure codes and billing codes; this data set was then manually screened to exclude reports that did not describe management of a thrombosed or dysfunctional hemodialysis circuit. Screening was performed in duplicate by two independent reviewers (I.M.N. and A.I.). Discrepancies were resolved by consensus between the two reviewers. If a consensus could not be reached, the input of a third, senior reviewer (A.D.B.) was used to determine the final eligibility of the study.

Assessment of procedural reports

To assess the content of radiology reports, we created a checklist of items derived from published reporting standards for percutaneous interventions in dialysis access and the SIR template for dialysis fistulogram and interventions (11,12). The checklist was created by a fellowship-trained interventional radiologist with five years of experience (A.D.B). Categories and elements from

published reporting standards that were included in the checklist were: referral indications, access description, prior interventions (date, type, lesion location), anatomic measures of disease severity (technique for lumen visualization, qualitative or quantitative measure of preprocedural stenosis, lesion location, central vein patency), treatment description, posttreatment evaluation, and complications. Elements from published reporting standards that were not included in the checklist were: comorbidities/risk factors, clinical (return to dialysis, continuous thrill, resolution of clinical abnormalities), device success, compliance, and procedure time. Although important, inclusion of these specific elements was not needed for the calculation of quality metrics, PiPP and PiLP. Relevant radiology reports were manually annotated according to the checklist. Annotation was performed in duplicate by two independent reviewers (I.M.N. and A.I.). Discrepancies were resolved by consensus between the two reviewers. If a consensus could not be reached, the input of a third, senior reviewer (A.D.B.) was used.

Assessment of self-sufficiency of reports

Following manual annotation, radiology reports were assessed to determine whether they were independently sufficient in providing the data required to calculate the selected outcomes. PiPP and PiLP were specifically chosen because, based on the experience of the authors, these metrics are the simplest to calculate, require inclusion of basic clinical/procedural histories, and are most clinically relevant, as they are associated with reintervention rates. Other outcome metrics that were considered include clinical success, hemodynamic success, postintervention assisted primary patency, postintervention secondary patency, and cumulative patency. These metrics were not pursued as they required inclusion of information that was not likely for an interventional radiologist to include in their reports, given that the institution, like most others in Canada, has not adopted the standard use of reporting templates.

The criteria for a report to be classified as “independently sufficient” was determined based on the definitions of PiPP and PiLP according to quality improvement guidelines (1,10). A report was classified as “independently sufficient” to calculate PiPP if it included the date, access description, type of prior intervention, and procedural information of the current intervention. A report was classified as “independently sufficient” to calculate PiLP if it included the location of prior intervention in addition to the criteria required to calculate PiPP.

Results

A total of 379,508 radiology reports were extracted for the period of May 28, 2019 to October 16, 2020. After filtering this initial data set for reports tagged with relevant procedure codes, we identified 140 reports. Following a final manual screening to exclude reports that did not describe management of a thrombosed or dysfunctional hemodialysis circuit, a total of 130 radiology reports describing 78 patients were included**.** All finalized radiology reports were produced and

signed by attending radiologists in the health system. In total, seven interventional radiologists performed these studies.

Patient demographic characteristics are detailed in Table 1. The mean age of the 78 patients included was 68.2 years (standard deviation: 13.3 years; range: 23 to 87 years) and 80.8% were male. Almost all patients had a fistula (96.2%), with more than half the patients having a radiocephalic access (56.4%). Just over three-quarters of the patients had a left-sided dialysis access (75.6%).

Table 1. Patient demographic characteristics (n=78)

Characteristic		**n (%)**
Age (mean [years] ± standard deviation (range))		68.2 ± 13.3 (23 – 87)
Gender, male		63 (80.8)
Dialysis access type	Graft	75 (96.2
	Fistula	3 (3.8)
Dialysis access location	Radiocephalic	44 (56.4)
	Brachiocephalic	31 (39.7)
	Brachiobasilic	2 (2.6)
	Brachiocubital	1 (1.3)
Dialysis access side, left		59 (75.6%)

Table 2 outlines the content of the procedural reports within the sample. All reports detailed techniques for lumen visualization and contained treatment descriptions. The least frequently included data elements were prior interventions (date, type, or location) (28.5%), access type (45.4%), and referral indications (63.9%). Only 3.9% (n=5) of reports contained all data elements included in the checklist. Of the 130 radiology reports included, 18.5% were independently sufficient in providing the information required to calculate PiPP (n=24), and 15.4% were independently sufficient to calculate PiLP (n=20).

Discussion

Determining whether an institution's IR practice is meeting guideline thresholds is a challenge, especially in the Canadian context. Although various QA systems exist, they are not widely implemented in Canadian institutions (13). As such, manual extraction of data from radiology reports from PACS and/or clinical histories from electronic medical records (EMR) are required to compare an IR program's performance with guideline thresholds. In most Canadian hospitals, EMR data are usually managed and regulated by the hospital system's information technology staff, whereas PACS is usually managed by the radiology department's IT staff. As a result, radiology reports are often more accessible to interventional radiologists for data mining and conducting QA activities.

In Canada, the retrospective collection of quality metrics can be time consuming. Due to challenges of accessing reports retrospectively and the fact that most institutions have not

Table 2. Completeness of radiology reports (n=130). Checklist criteria derived from the Society of Interventional Radiology template for dialysis fistulogram and interventions.

Checklist criteria	**n (%)**
Referral indications (either screening method or access failure indication)	83 (63.9)
Access type (e.g., brachiocephalic, radiocephalic, etc)	59 (45.4)
Prior Interventions (any data)	37 (28.5)
Date of intervention	31 (23.9)
Type of intervention	30 (23.1)
Lesion location	22 (16.9)
Anatomic measures of disease severity	
Technique for lumen visualization (ex. fistulogram, ultrasound, venogram, etc.)	130 (100)
Qualitative or quantitative measure of preprocedural stenosis (<30%)	83 (63.9)
Lesion location	128 (98.5)
Central vein patency	94 (72.3)
Treatment description	130 (100)
Posttreatment qualitative or quantitative measure of postprocedural stenosis (<30%)	127 (97.7)
Complications	112 (86.1)

adopted the standard use of reporting templates, calculating PiPP and PiLP would require administrators to first identify relevant procedure codes, filter reports accordingly, exclude those that do not describe a percutaneous image-guided intervention, sort the remaining reports by patient, manually annotate for date, type, and location of lesion (assuming that this information is contained), and, finally, calculate the time difference between consecutive interventions. These results would then need to be tabulated to compare the IR practice's reintervention rate(s) with quality guideline thresholds. This workflow assumes the necessary data are contained within the report.

Although the literature describes the importance of patient-centered outcomes measure in radiology, this study is the first of its kind to assess inclusion of certain elements in radiology reports to enable the retrospective calculation of quality metrics. This study found that documentation of items derived from published reporting standards for percutaneous interventions in dialysis access was low, with only 3.9% of reports containing all the elements in the checklist. Additionally, only 18.5% and 15.4% of radiology reports were independently sufficient to calculate PiPP and PiLP, respectively. Furthermore, reports were not explicitly categorized as structured (itemized or tabular) versus unstructured (prose) because most reports used a mix of the two approaches, containing headings to enumerate specific categories while the descriptions associated with them were largely prose. This is not a criticism of the reports or the interventionists in this sample, as no standard reporting requirements currently exist at the institution, nor are there any government reporting mandates in place. The findings of this study suggest that non-implementation of published reporting standards may hinder the retrospective quality assessments required in quality improvement programs.

The literature encourages the adoption of standardized reporting templates (9,14-20). McWilliams et al. reported that, among the 10 IR practices that deployed standardized reporting templates, the mean report usage rate was 57% (9). Additionally, they found that each of the sites observed in their study modified the original report template, and on average reduced the length by 26%, the word count by 18%, and the number of compulsory fields by 60% (9). Further statistical analysis found that reducing the number of compulsory fields was significantly correlated with increased rates of use [R2=0.444; P=0.05], suggesting that simple, customizable templates are better implemented (9). Similarly, Boseman et al. formed a focus group of 11 attending radiologists representing eight countries to identify barriers to the adoption of standardized reporting by radiology departments (17). The study found that radiologists judged reporting within a rigid frame as "unacceptable." Additionally, participants expressed that other healthcare stakeholders imposed standardized reporting without considering the perspectives of practicing radiologists. However, radiologists agreed that, given their acceptance of the advantages of reporting, they would be more likely to engage positively if templates were provided, especially where such tools did not compromise accuracy of reporting and workflows (17).

The most robust standardized reporting template for IR procedures are SIR templates (21). In 2021, SIR launched a new data registry, VIRTEX, designed to enable IR practices to compile standard sets of data to benchmark and improve patient care outcomes (21). The primary objective of VIRTEX is to establish data-driven, evidence-based patient care (21). VIRTEX encourages the use of SIR's standardized reporting templates, as the templates offer a structured and automated way to submit data to the registry (21). This study supports the need for greater standardization as advocated for by the creators of VIRTEX registry and the importance of reporting certain elements, particularly details of prior interventions, a data element not explicitly required in the current SIR standardized template (11,12). Our findings suggest that including the date, access description, type, and lesion location of prior and current interventions in reports would facilitate data mining in the care of patients with dysfunctional hemodialysis circuits. The suggestions above would enable reports to provide the data necessary to support QA programs, particularly in the calculation of PiPP and PiLP, and they align with the objectives of VIRTEX (21).

This study has some limitations. First, the report data set was mined from a single institution. Local factors, such as case mix and implicit preferences of radiologists and referring clinicians, may limit generalizability. Second, the selection of relevant reports was based on PACS procedure codes; it is possible that other relevant reports indexed with an incorrect procedure code may not have been captured in the final data set. Additionally, this study assumed that all relevant information for quality improvement assessments was contained within the radiology reports. EMR were not accessed, cross-referenced, or validated in this study. By utilizing additional records, it may have been possible to obtain the information necessary to calculate the outcome metrics of interest (PiPP and PiLP). However, the objective of this study was to assess the content of radiology reports independent of other data sources, as this may be more representative of QA data mining in a real-world setting.

Conclusion

Data mining from procedural reports of percutaneous interventions in dialysis access may provide the data to support QA activities in an IR practice. However, few reports in the dataset were independently sufficient to calculate the quality outcome metrics suggested by international guidelines. Standardized reporting has the potential to improve communication, promote adherence to guidelines, and provide data for quality improvement projects to optimize patient care. This study supports the need for greater standardization as advocated for by the creators of VIRTEX registry.

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