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TRACKING CATHETERIZATION LABORATORY TIME AT NORK-MARASH MEDICAL CENTER

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Summary

Objectives
The study explored the duration of catheterization procedures in the catheterization laboratory (CL) of the Nork Marash Medical Center (NMMC), by tracking patients from the time of their entrance to CL to exit. The duration of procedures such as total procedure time and fluoroscopy time are parameters that depict operator performance/competence. Other indicators of operator performance (complication rates, diagnostic quality of the studies) were not monitored because they are not routinely recorded in the CL. The assessment of procedure times could help the staff of CL to more efficiently schedule patients.

Methods
A cross-sectional record review of the time spent by 87 sequential patients in the CL was conducted by registering start and end times of almost all procedures performed by different members of the cardiac catheterization team. Additional 24 catheterizations in children were examined by registering only the fluoroscopy times.

Results
Patients stayed in CL for 62 minutes on. Time spent in CL was different for diagnostic and interventional procedures (58.61 vs. 88.42 minutes, p=0.02). Total procedure time was significantly shorter in the CL compared to western clinics (29.26 vs. 47.6). The average scope times for adult catheterizations were 5.25 minutes for diagnostic and 12.62 minutes for interventional procedures. These times were not significantly different from those in western clinics. Scope times for pediatric catheterizations were 18.88 minutes for diagnostic and 27.83 minutes for interventional procedures. Almost no variability was found between the duration of procedures among different adult cardiologists.

Conclusions
Small post-procedural waiting time, similar operator performance in terms of procedure duration, and comparable characteristics of operator performance implies that almost all the members of the team participating in catheterization at NMMC are working within acceptable standards.

It is recommended to improve the system of scheduling patients for procedures in CL.
It would be beneficial to enhance data collection in CL for quality assurance purposes.

Introduction

Monitoring of quality indicators in Nork Marash Medical center (NMMC) catheterization laboratory is a component of the American University of Armenia/NMMC collaborative project.

Assessing the current state of performance is a key step in quality improvement efforts. According to Donabedian, the first step of the quality improvement cycle is "obtaining data on performance" (1). Donabedian states "the detailed characteristics of health care processes can provide discriminating and valid judgments about the quality of care". The processes of care are directly related to outcomes (1).

Catheterization laboratory (CL) is one of the important functional departments of NMMC. For quality assurance purposes it is essential for CL to have information on the parameters of operator performance/competence such as total procedure time, fluoroscopy time, contrast material usage, complications, and diagnostic quality of the studies (2). The complication rate in CL at NMMC would be very hard to monitor, as complications are not recorded routinely. Diagnostic quality of the studies is a very important indicator of quality of CL, however, the researcher should be proficient in this area, or the laboratory should have a system for assessment. Since these prerequisites were lacking in this study, other important indicators of quality control in CL such as the duration of different consecutive procedures conducted during patient catheterization, concentrating specifically on the time of fluoroscopy (or scope time) were selected.

The aim of any fluoroscopic examination should be to achieve maximum quality of care with minimum radiation exposure to patient and staff. According to the US National Council on Radiation Protection and Measurement (NCRPM), "there is no threshold, below which harmful effects may not occur". The use of ALARA—"as low as reasonably achievable"—doses of radiation should always be considered (3).

Fluoroscopy time at NMMC is counted by a specific device and recorded by technicians. Fluoroscopy times over 15 minutes are uncommon, and over 30 minutes are very rare (4). Fluoroscopic timers are used in CL at NMMC to alert physicians to the total duration of x-ray exposure by sounding an audible signal every 5 minutes of exposure. The length of fluoroscopy and total procedure time are affected by manual dexterity, experience and observational skills of the invasive cardiologist (2). The following variables may influence fluoroscopy time: type of procedure (diagnostic vs. interventional), operator education, experience, and patient condition (3).

Along with operator proficiency, management of the catheterization process affects total procedure duration, specifically waiting time before transportation to departments and total time spent by a patient in CL. According to the CL head nurse, they do not assign patients precise times because elective patients often spend unpredictable amounts of time settling administrative problems (payments) and undergoing assessments prior to the start of the catheterization.

The present study observed the total time spent by a patient in CL, total duration of the procedure, scope time/fluoroscopy time, duration of patient preparation for catheterization, duration of angioplasty, performance of different team members (nurses, physicians, residents, fellows), and waiting time after finishing the procedure.

The work caseload is also a factor associated with operator and laboratory proficiency (2). Laboratories doing more than 500 catheterizations per year have the lowest rate of complications (3). Considering modern efficiency expectations (1000 cases per year), 500 cases would be considered a minimum per laboratory (2, 3, 6). The US Society for Cardiac Angiography and Intervention recommendes that a minimum of 150 cases per year be performed per adult invasive cardiologist in the laboratory.

Pediatric catheterizations often encounter challenges and differences not faced by adult invasive cardiovascular specialists. Generally, the internal structure of heart is abnormal in pediatric catheterizations (unlike that in adult cardiology). Diagnostic catheterization may include quantitation of the cardiac index, and calculations of left-to-right and right-to-left shunts and pulmonary vascular resistance. Right- and left-heart catheterization is a norm rather than an exception for pediatric catheterizations. Because of periods of rapid growth in infancy and childhood and the need for comparison of data across sizes of patients or over time in the same person, output and resistance values are indexed or corrected in children for body surface area. All of these factors make the catheterization duration in pediatric cardiology longer and non-comparable with that in adult cardiology.

However, children are more susceptible to radiation-induced cancer than adults, because they are developing and having longer life expectancy, giving the cancer a longer time to develop. Therefore it is extremely important that any radiological examination in children is performed with minimum possible dose (7).

The American Academy of Pediatrics guidelines issued in 1991, recommend that a minimum of 1 to 2 catheterizations per week be performed by a pediatric invasive cardiologist to maintain the needed skills. Thus, for a cardiologist, the minimum number of cases is still thought to be at least 50 per year (3).

Study objectives

The specific objectives of the study were to identify:

- total duration of the time spent by patients in the catheterization laboratory;
- total duration of catheterization and specific durations of fluoroscopy and other sub-procedures;
- post-procedural waiting time.

Methods

A cross-sectional record review of the time spent in CL of 87 patients was conducted. The sample size of the study was determined using one-sample comparison of mean formula (H_0: mean fluoroscopy time = 5.9 minutes) and increased for the planned analysis.

All patients referred for diagnostic cardiac catheterization during the time between 21 November and 13 December 2003, were included in the study. Start and end times for each sub-procedure were recorded by catheterization nurses, who were present during the entire procedure. Scope times were extracted from the technician's journals. Among the 87 studied patients, 2 were children, whose scope times notably exceeded the scope times for adults, that is why additional 24 records of pediatric catheterizations' scope times were extracted from the journals.

Prior to the observations, a time tracking tool was developed in collaboration with the nurse manager of the CL (Appendix 1,2). Nurses conducting the observation were counseled about the data collection process before starting the observations.

The accepted, routine practice for cardiac catheterization in NMMC is for the patient to first be served by nurses who prepare him for catheterization: explain the procedure again, organize the procedural logistics, place the patient and sedate him. This time was combined into “pre-procedural preparation”. Then a resident/nurse prepares the access site, which was defined as “preparation to catheterization”. Afterwards, residents/fellows perform local anesthesia and insert vascular catheters. The invasive cardiologist injects contrast media and then scopes the vessels. After that, the sheath is removed (for diagnostic catheterization) and proper hemostasis achieved. The duration from the local anesthesia/sheath insertion up to achieving hemostasis was combined into “total duration of procedure.” After the end of procedure, the patient waits before being transferred to the corresponding department.
The following data were registered:

- start and end time of patient preprocedural preparation
- start and end time of patient preparation to catheterization
- start and end time of coronarography (the invasive cardiologist is also specified)
- scope time (fluoroscopy time)
- start and end time of angioplasty (the interventional cardiologist is also specified)
- time of patient replacement to other departments (the department is also specified)

Data analysis
The data was entered and analyzed using SPSS 10.0 statistical package.

Results

The CL of NMMC performed 1,308 cardiac catheterizations during 2003, which is more than the minimum caseload set for catheterization laboratories by US Society for Cardiac Angiography and Intervention (3). The annual rate of cardiac catheterizations was under-recorded (949 compared to 1308) in Adult cardiology clinic database (ACC). The data presented directly by CL (1,308 per annum) is more valid but do not contain the number of catheterizations performed by different invasive cardiologists that is why the operator caseload was calculated based on ACC data. Taking into account the underreporting of cardiac catheterizations in the database of ACC, the majority of invasive cardiologists (staff of NMMC) performed more than 150 procedures per year (Table 1). Pediatric invasive cardiologists performed fewer catheterizations than the minimums required by the American Academy of Pediatrics.

Data analysis revealed that patients spent in CL 62.77 minutes on average (Table 2). The mean time spent in catheterization laboratory by patients undergoing angioplasty (interventional procedure) was longer than for those undergoing only coronarography (diagnostic procedure). This difference was statistically significant (p=0.02).

Table 1. Annual number of diagnostic cardiac catheterizations

	Invasive cardiologist	Number of coronarographies in 2003
Adult catheterizations	A	171
	B	300
	C	150
	D	148
	E*	121
	Others	75
	Subtotal	949
Pediatric catheterizations	Subtotal	22
	Total	973 (recorded by ACC) vs. 1308 (recorded by CL)

* E is not invasive cardiologist, so 121 of her patients were catheterized by other invasive cardiologists

Table 2. Total time spent in catheterization laboratory

Type of procedure	N	Minimum	Maximum	Mean	Std. Deviation
diagnostic	74	30.00	162.00	58.61	21.09
interventional	12	38.00	170.00	88.42	37.53
total time	86	30.00	170.00	62.77	25.93

Table 3 summarizes the duration of sub-procedures and waiting time after the end of procedures. The mean duration of procedures before coronarography was 13.96 minutes including the durations of sedation and access site preparation.

Table 3. The duration of all sub-procedures and post-procedural waiting time*

	N	Minimum	Maximum	Mean	Std. Deviation
duration of sedation and pre-procedural preparation	86	0.00	25.00	5.90	3.68
duration of preparation to catheterization	87	1.00	30.00	8.06	5.99
duration of coronarography	78	3.00	100.00	30.73	19.97
duration of angioplasty	11	14.00	70.00	33.18	16.89
duration of patient replacement	87	1.00	35.00	7.55	5.88

** The means are calculated for the whole study sample, including the two pediatric cases that were outliers*

The mean duration of the total diagnostic procedure for adult patients was 29.26 minutes (sd=16.74) at NMMC catheterization laboratory. According to Cooper et al., in their lab, the duration of this procedure with femoral access site[**] for 99 patients was 47.6 minutes (sd=2.7) (5). The difference was significant (p=0.000), meaning that the total duration of this procedure was significantly shorter in CL of NMMC. However, as shown later in this report, scope time was not significantly different between NMMC and the reference study.

The duration of the total procedure was the same for almost all operators, except for operator H. However, she performed only two coronarographies, and the difference could be due to chance alone.

[**] The majority of catheterizations at NMMC are performed through femoral artery

The mean scope/fluoroscopy time for all adult patients was 6.12 minutes (Table 4). As expected the scope time for patients undergoing angioplasty was significantly longer than for those undergoing only coronarography 12.62 vs. 5.25 minutes (p=0.014).

Table 4. Duration of scope time for adult patients

Type of procedure	Scope time			
	Minimum	Maximum	Mean	Std. Deviation
coronarography	1.40	19.90	5.25	3.94
angioplasty	5.50	29.40	12.62	7.69
total	1.40	29.40	6.12	5.08

As summarized in Table 5, the scope times for different adult cardiologists were similar (p=0.191).

Table 5. Duration of scope time by operator and by the type of procedure

Type of procedure	Physician	Scope time			
		Mean	Minimum	Maximum	Std Deviation
Diagnostic	A	3.91	1.40	10.10	2.35
	B	4.63	1.80	17.40	3.59
	C	6.02	2.30	13.80	3.66
	F	7.32	2.90	19.90	5.89
	G	9.27	4.40	18.30	7.83
	H	9.45	7.90	11.00	2.19
Interventional	A	10.79	5.50	29.40	8.47
	C	16.90	14.50	20.80	3.41

The mean scope time for diagnostic procedure was 5.25 minutes (sd=3.94) compared to Cooper et al 5.90 (sd=4.80) (5). The difference was not significant (p=0.158).

The mean duration of interventional procedures (angioplasty) was 33.18 minutes (Table 6). The mean duration of scope time for this procedure was similar in NMMC (12.62) and the Department of Thoracic Radiology, University Hospital, Linköping (10.5) p=0.538 (8). The difference of the duration of angioplasty between different providers (Drs. A and C) was not significant (p=0.258), although this could be due to small sample size.

Table 6. Duration of angioplasty

Interventional cardiologist	N	Minimum	Maximum	Mean	Std. Deviation
A	8	14.00	70.00	29.50	18.43
C	3	36.00	48.00	43.00	6.24
Total	11	14.00	70.00	33.18	16.89

As mentioned above, among the 87 studied patients, two were children whose scope times notably exceeded the scope times for adults (27.35 vs. 5.25 minutes). To make a correct judgment about this difference, an additional 24 records of pediatric catheterizations' scope times were extracted from the journals. The mean scope time for pediatric catheterizations at NMMC was found to be 23.35 minutes. The mean scope times for different types of pediatric procedures were not significantly different, perhaps, due to the small sample size (Table 7).

Table 7. Mean scope time for pediatric catheterizations

Type of procedure	**Scope time**			
	Minimum	**Maximum**	**Mean**	**Std. Deviation**
Diagnostic procedure	7.10	41.70	18.87	11.28
Interventional procedure	8.00	68.80	27.83	19.48
Total	7.10	68.80	23.35	16.23

The pediatric cases were analyzed by the type of procedure (Table 8). The mean fluoroscopy time was longer for interventional procedures except for ASO placement.

Table 8. Mean scope time by the type of procedure (performed to pediatric patients)

Type of procedure	**Scope time**				
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
diagnostic	12	7.10	41.70	18.87	11.28
balloon	6	15.10	46.20	23.45	11.43
stent	1	60.00	60.00	60.00	N/A
balloon +stent	2	24.70	68.80	46.75	31.18
occluder	3	8.00	17.60	13.27	4.87

Only a reference for the mean scope time for transcatheter closure of atrial septal defects in children using Amplatzer Septal Occluder (ASO) was found. This was not significantly different in NMMC (13.27 minutes) and University of Chicago Children's Hospital (17.1 minutes), p=0.306 (9).

Only three specialists were involved in pediatric catheterization procedures. The main pediatric invasive cardiologist at NMMC is Dr. A. The other operators were Drs. B and Dr. C, an experienced consultant periodically visiting NMMC from Spokane, Washington for limited durations. Although generally the procedures were conducted with Dr. C were shorter than the others (Table 9), the mean scope times of pediatric procedures by providers were similar according to the t-test for equality of means (p=0.778). The absence of significant difference between these operators' performance could be due to real similarity in performance or an artifact of the small sample size.

Table 9. Mean scope time for different providers

Type of procedure	**Invasive pediatric cardiologist**	**Scope time**				
		N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Diagnostic	A	7	8.20	33.50	17.93	9.88
	A+B	2	15.90	41.70	28.80	18.24
	A+C	3	7.10	26.50	14.47	10.51
	Subtotal	12	7.10	41.70	18.88	11.28
Interventional	A	2	21.20	46.20	33.70	17.68
	A+C	7	8.00	68.80	31.09	23.51
	B+C	3	14.20	17.60	16.33	1.86
	Subtotal	12	8.00	68.80	27.83	19.48
Total		24	7.10	68.80	23.35	16.23

The mean patient waiting time after the procedure and before movement from CL to wards or intensive care unit (ICU) was 7.55 minutes (Table 10). However, there were cases when patients waited up to 35 minutes. The mean time for replacement was the shortest for those transferred to catheterization care unit (CCU) and longest for those to be transferred to ICU. The difference, however, was not statistically significant (p=0.192)

Table 10. Comparison of patient waiting time prior to transport

Department	Patient waiting time (minutes)				
	N	Minimum	Maximum	Mean	Standard Deviation
ICU	18	2.00	27.00	9.83	8.35
CCU	50	1.00	35.00	6.46	5.26
ward	17	3.00	15.00	8.35	4.03
other	2	5.00	10.00	7.50	3.54
total	87	1.00	35.00	7.55	5.88

The transfer of patient by different wards was found to be similar (p>0.05)

The duration between consecutive procedures was on average 15.00 minutes (sd=6.00). Generally, this time is required for cleaning the laboratory before the next procedure.

Study limitations

A study limitation was that patient health status was assessed only by the category of procedure: diagnostic or interventional. Several other factors influencing patient condition and the duration of the total procedure or fluoroscopy time were not assessed.

Another limitation of the study was the small number of pediatric catheterizations in the sample, which could hinder detecting significant differences.

The range of quality indicators assessed in this study was limited to procedure/waiting times because of the lack of recording of critical information (e.g. indications for procedure, complication rates, etc.) in the routine forms of catheterization/angioplasty.

Conclusion

This study showed that the workload of adult invasive cardiologists is with the recommended norms needed for appropriate proficiency. Procedure times for adult catheterizations at CL were shorter and fluoroscopy times did not differ from that in the US specialized centers and did not exceed recommended levels. For almost all providers of ACC the length of procedure times and fluoroscopy times did not differ significantly.

The workload of pediatric invasive cardiologists was lower than the recommended minimum. Scope times for pediatric catheterizations seemed to be longer than recommended, but similar across pediatric invasive cardiologists, which could be due to true similarity or small sample size.

The transport of patients to departments did not differ significantly by department and the waiting time of patients was not excessive, although there is room for improvement in this area.

Acceptable durations of procedure and waiting times with similar operator performance imply that almost all members of the team involved in catheterization are working within recommended standards and it could be assumed also that the process of catheterization is well managed.

Recommendations

Based on the results of this quality monitoring project in CL the following measures are recommended:

- Enhancing data recording at CL. Cardiac catheterization and angiography records should contain certain critical information. Some information is not included in the report, such as the indications for procedure, complication rates. The limited data recorded in CL creates difficulties for monitoring quality. A new structured catheterization form with all necessary information is strongly recommended.
- Tracking the patient not only during the procedure, but also before procedure, to assess the time patient spent on administrative preparation of documents, payments, exams before catheterization, and waiting times before entering CL.
- Scheduling patients to precise times, according to the findings of the present study. The following time intervals are recommended: 1 hour + 15 minutes (for cleaning after the procedure) for diagnostic catheterization and 1 hour 20 minutes +15 minutes for interventional procedures.
- Organizing training for pediatric invasive cardiologists in the centers with greater caseload than in NMMC.
- Repeating the monitoring of procedure times duration periodically, to assess quality changes.
- After improving the registration forms, conducting monitoring of other important indicators at CL, such as risk-adjusted complication rates.

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Appendix 1 Time tracking tool

Tracking the time patient spend in Catheterization Laboratory/ Monitoring quality indicators

Please, register the time accurately

Date	Patient name	Patient entrance to CL	Patient preparation to catheterization		Coronarography		Scope time	Angioplasty		Patient replacement	Department	Cardiologist
			Start	End	Start-sheath insertion	End		Start	End			