A Comparison of the Effectiveness of Dual Catheter and Embedded Catheter Techniques used for PE Thrombolysis

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Abstract

Pulmonary Embolism (PE) is a blockage of a major blood vessel in the lung, which commonly occurs when a blood clot that forms in the lower extremities breaks loose and becomes lodged in the circulatory system of the lungs. The standard medical treatment of patients with a PE is systemic intravenous thrombolysis; however administering a systemic thrombolytic agent is associated with hemorrhage risks and also the small risk of hemorrhagic stroke.

One alternative to systematic intravenous thrombolysis is catheter-directed therapy (CDT) utilizing tissue plasminogen activator (tPA). There are multiple methods of CDT that vary in the process of delivery and amount of the lytic, as well as the number of catheters used, however the most effective method has not been well established. The purpose of this study is to compare patient outcome data regarding the use of single and dual catheter directed therapies and intrathrombotic and extrathrombotic lytic administration.

A retrospective analysis of patient data was conducted on a sample of 35 patients with a known PE who underwent a CDT tPA administration. A point biserial test was used to evaluate the relationship between the two independent variables, single and dual catheter(s) and catheter placement (intrathrombus or proximal to the thrombus) to two dependent variables, duration and pulmonary artery pressure.

The results of the test showed no significant correlation. Contingency table measures of association were used to examine the two independent variables and dependent variable of the presence of Right Ventricular Dysfunction. Results were reported as phi coefficients and showed no significant correlation. These findings indicate that there is not a significant

correlation between the independent variables and the dependent variables. Previous research indicates a significant decrease in mortality when the PE is detected early and the correct treatment is performed. This study, although limited, helps to identify best methods in the CDT treatment of PE.

Chapter 1

The Problem

Pulmonary Embolism (PE) is a sudden blockage of a major blood vessel in the lung, most commonly due to a blood clot that forms in the lower extremities, breaks loose and becomes lodged in the circulatory system of the lungs. If the blood clot forms in a deep vein, rather than a vein close to the skin, it can lead to a PE. In some cases, the clots are small with a low mortality rate, but they can damage the lung. However, a large clot that interrupts blood flow to the lung can be deadly if not treated quickly.

Massive pulmonary embolism is a common life threatening condition. The onset of a PE is very rapid and may result in shock, cardiac arrest, pulmonary infarction, pleural effusion, pulmonary hypertension and death if it remains untreated. In the United States, an estimated 530,000 cases of systematic PE occur and approximately 300,000 people die every year from acute PE (Kuo, Gould, Louie et al., 2009). The thirty day mortality rate for massive PE is approaching 30%, and the presence of shock in these patients defines a three-to- seven fold increase in mortality, with a majority of deaths occurring in 1 hour of presentation (Banovac, Buckley,Kou, et al., 2010).

The role of the interventional radiologist continues to evolve with the role shifting from diagnosis to treatment of the PE. The standard medical treatment of patients with a massive PE is systemic intravenous thrombolysis; however administering a systemic thrombolytic agent is associated with major hemorrhage risks and also the small risk of hemorrhagic stroke (Kuo, Gould, Louie et al., 2009). In addition, it is unclear which alternative treatment should be used when systemic intravenous thrombolysis is contraindicated. One alternative to systemic

intravenous thrombolysis is catheter-directed therapy (CDT) utilizing tissue plasminogen activator (tPA). There are multiple methods of CDT that vary in the process of delivery of the lytic, the number of catheters used and the amount of lytic delivered. One method used to deliver the lytic to the embolism involves embedding the catheter into the thrombosis and delivering a set amount of medication over a longer period of time varying from hours to days. Another delivery method includes using two catheters, one to deliver the lytic and one to mechanically break up the clot. However, the safety and efficiency of the various methods of CDT have not been firmly established. Cases have been documented in which patients treated with tPA via CDT do not improve hemodynamically and require urgent endovascular mechanical thrombectomy with local pharmacologic intervention (Kuo, Gould, Louie et al., 2009).

In cases of massive PE, interventional radiologists currently use either catheter directed therapy, mechanical thrombectomy; or a combination of the two, in an effort to restore pulmonary blood flow in a life saving effort. There is a significant decrease in mortality when the PE is detected early and the correct treatment is performed (Banovac, Buckley,Kou, et al., 2010). Therefore the purpose of this study is to compare the use of single and dual catheter directed therapies in terms of patient outcomes; and to compare internally embedded administration of tPA versus external administration of tPA in terms of patient outcomes. Patient outcomes will be assessed by: 1) the duration of treatment , 2) presence of pre-procedural right ventricular dysfunction (RVD), and 3) measurement of pre- and post-procedural pulmonary artery (PA) pressure.

Review of Literature

PE is a sudden blockage of a deep vein within the lung usually from a blood clot traveling from the leg. The risk factors associated with PE include increased age, obesity (body mass index >30 kg/m^2), recent surgery, immobilization, chronic heart disease, fracture of long bones, pregnancy, varicose veins and smoking >25 cigarettes per day (Banovac, Buckley,Kou, et al., 2010). Currently, CT angiography is the clinically preferred modality to diagnose PE and has largely replaced pulmonary angiography at most institutions (Ghaye, Ghuysen, Bruyere, et al.,2006). Early detection is critical for accurate treatment because it allows physicians to decide the best treatment option based on each patient's needs (Kuo, Gould, Louie et al., 2009).

The current "gold standard" for treatment of PE is anticoagulation and systemic thrombolytic therapy. Banovac, Buckley,Kou, et al. (2010) report an 8% decrease in mortality rate in patients who have received anticoagulation and systemic treatment of PE, where as untreated, PE carries a 30% mortality rate. Although systemic thrombolytic therapy is the current gold standard, there is still a risk of hemorrhage and an increase of oral coagulant use post procedure (Banovac, Buckley,Kou, et al., 2010).

Catheter- directed thrombolysis (CDT) is an image guided technique that is used to deliver the thrombolytic agent, tissue plasminogen activator (tPA), directly to the thrombus through an endovascular catheter. tPA was approved by the FDA in 1996 as a thrombolytic agent that has been effective in the breaking down of blood clots. tPA is an enzyme that catalyzes the conversion of plasminogen to plasmin, the major enzyme responsible for clot breakdown. Administration of tPA through CDT followed by an anticoagulant, such as heparin,

has been proven very effective in the breakdown of pulmonary emboli (Goldhaber, 2001). One disadvantage of tPA is the increase risk of hemorrhage in the patient (Goldhaber, 2001).

An exhaustive literature search was conducted with few studies located specific to PE thrombolysis. The search was extended to other vascular studies in which thrombolytic agents were used in the treatment of occlusive disease. In a study conducted regarding thrombolysis for the cerebral arteries in patients with an ischemic stroke, it was found that the risk of hemorrhage may be increased with no intervention. But the risk of hemorrhage is also lower using catheter directed tPA compared to systemic treatment because the localized low doses of lytic avoids the potential for systemic hemorrhage complications by acting selectively at the site of thrombosis. (Castro, 1996).

CDT has been performed on patients with massive PE who could not tolerate systemic thrombolysis, patients who failed systemic thrombolysis , or in cases when there was insufficient time to infuse thrombolytics (Kuo, Gould, Louie et al.,2009). CDT presents the advantage of a more rapid resolution of thrombi which is of fundamental importance in the prognosis of hemodynamically unstable patients (Spanodimos, Antonatos, Sotirellos, et al., 2002). CDT has also been proven to be useful for patients with relative contradictions to systemic anticoagulantive treatment, such as recent abdominal surgery, pregnancy and severe allergic or idiosyncratic reactions to anticoagulants (Banovac, Buckley,Kou , et al., 2010). Because the main cause of death due to massive PE is attributed to irreversible right ventricular failure, early revascularization of the pulmonary bed in an effort to decrease right ventricular afterload has been a goal of CDT (Banovac, Buckley, Kou, et al., 2010). CDT also involves risks,

and may need to be combined with mechanical thrombectomy to increase the success rate of the procedure.

The methods and delivery of the lytic to the thrombus may vary from case to case. Some of the methods include using a single catheter or dual catheters, as well as placing the catheter intrathrombic or proximal to the thrombus to deliver the lytic. After an extensive literature search for information on embedded catheters in the breakdown of pulmonary embolisms, information seemed to be only available on the use of embedded catheters in the breakdown of intracranial thrombosis. The use of embedded catheters for pulmonary embolisms is a relatively new procedure with little information reported in the current literature. However, there has been a proven advantage embedding catheters in intracranial catheterizations (Jungreis, Wechsler, & Horton, 2010). The systemic effects of the thrombolytic agents are minimized when the catheter is embedded into the thrombosis resulting in a decrease of hemorrhages when compared to systemic intravenous administration (Jungreis, Wechsler, & Horton, 2010). Embedding the catheter into the clot requires a trained interventionalist and carries the usual risks associated with angiography (Jungreis, Wechsler, & Horton, 2010). Potential risks associated with embedding the catheter include arterial rupture, injury of the perforating artery and spasm. (Ikushima, Ohta, Hirai, et al, 2007)

A different type of treatment involves using dual catheters, one to deliver a lytic and one to break up the clot. This method has been shown effective in acute iliofemoral DVT as a complete or partial thrombosis (Vedantham, Milward, Cardella, et al., 2006). This dual catheter directed therapy is recommended for patients who show signs of circulatory compromise (Vedantham, Milward, Cardella, et al., 2006) .

The Objective

The purpose of this study is to:

1. Compare patient outcome data regarding the use of single and dual catheter directed therapies in terms of:
    a. duration of treatment
    b. presence of pre-procedural right ventricular dysfunction (RVD)
    c. change in systolic pulmonary artery (PA) pressure
2. Compare patient outcome data regarding tPA administration using intrathrombic catheter versus catheter proximal to thrombus:
    a. duration of treatment
    b. presence of pre-procedural right ventricular dysfunction (RVD)
    c. change in systolic pulmonary artery (PA) pressure

Hypotheses

1. There is no relationship between the duration of the thrombolytic procedure and the type of catheter (single or dual tip).
2. There is no relationship between the presence of existing right ventricular dysfunction (RVD) and the type of catheter (single or dual tip).
3. There is no relationship between the change in pre and post systolic pulmonary artery pressure and the type of catheter (single or dual tip).
4. There is no relationship between the duration of the thrombolytic procedure and thrombolytic agent instillation.

5. There is no relationship between the presence of existing right ventricular dysfunction (RVD) and thrombolytic agent instillation.
6. There is no relationship between the change in pre and post systolic pulmonary artery pressure and thrombolytic agent instillation.

Definitions

tPA -a protein involved in the breakdown of blood clots. Specifically it is a serine protease found on endothelial cells. As an enzyme, it catalyzes the conversion of plasminogen to plasmin, the major enzyme responsible for clot breakdown.

Catheter Directed Therapy or Catheter Directed Thrombolysis (CDT) - an interventional radiology treatment that uses targeted image-guided drug delivery with specially designed catheters to dissolve dangerous blood clots in the lungs

Dual Thrombolysis Catheter- Two Catheters that arrange in a coaxial fashion with inflatable balloons on each distal tip. The inner catheter infused the thrombolytic agent, Aspiration is accomplished through the outer catheter, resulting in the break up of the clot.

Right Ventricular Dysfunction (RVD)- A condition where the right ventricles of the heart exhibit decreased function. Determined in this study by the hypertrophy of the right ventricle seen on pre-procedural CT.

Pulmonary Artery Pressure (PAP)- The measurement of the systolic blood pressure found in the pulmonary artery; determined in this study directly before and after the CDT with catheter(s) placed directly in the pulmonary artery.

Chapter 2

Methodology

This is a retrospective analysis of an existing dataset collected by Sumit Bhatla, MD, and Pablo Gamboa, MD, Riverside Department of Interventional Radiology, comparing methods of thrombolysis and patient outcomes. This study has been approved by The Ohio State University Institutional Review Board. A convenience sample of 49 patients with indications for PE over 18 years of age was analyzed regarding the CDT method and tPA administration method.

The data set of 49 patients was randomly chosen by Sumit Bhatla, MD and Pablo Gamboa, MD. An Excel spreadsheet was created to record the data. Patient (coded 1-49), procedure, number of catheters, placement of catheter(s), pre systolic PA pressure, post systolic PA pressure, duration of treatment, and complications were all recorded. The data contained no direct identifiers. After all data was collected some patients were eliminated because they did not meet requirements of established criteria. Of the 49 original patients, 14 were eliminated due to because the patients did not have a true pulmonary embolism or they had developing a life threatening condition in which CDT was contraindicated. The information from the remaining 35 patients was analyzed using IBM SPSS Statistics 19. Descriptive frequencies are reported for all variables in this study.

The first dichotomous nominal independent variable recorded for this study was single versus dual catheter(s), recorded as (1) single and (2) dual. The second dichotomous nominal independent variable recorded for this study catheter placement (intrathrombus or proximal to the thrombus), recorded as (1) intrathrombus and (2) proximal to the thrombus. A point bi-serial test of significance was used to assess the relationship between the each independent

variable and the two dependent variables. The first dependent was the duration of treatment, coded as (1) less than or equal to 12 hours; (2) 13-24 hours; (3)25-36 hours ; (4) 37-48 hours = 4 and (5) greater than or equal to 49 hours. The coding of duration was recorded in the intervals mentioned since most patients were checked every eight to 12 hours for change in systolic PA pressure and reduction in embolism size. The second dependent variable was change in systolic pulmonary arterial pressure, recorded as (0) no change in pressure to a change or -5mmHg, (-1) change or -5 to -15 mmHg, (-2) change of greater than or equal to 16mmHg.

Contingency table measures of association were used to examine the two independent variables and the existing presence of Right Ventricular Dysfunction (yes (1) or no (2)). Results were reported as phi coefficients.

Chapter 3

Results

Descriptive Data

The sample for this study was thirty five patients with known pulmonary embolisms who underwent a CDT with tPA administration. All subjects underwent their CDT within a period of one year, and all procedures were performed at Riverside Methodist Hospital. Factors for exclusion for this study included age < 18 years, patients who did not have a confirmed diagnosis of PE, patients who only underwent heparin therapy for their pulmonary embolisms and patients who could not finish their CDT due to complications.

Physician preference and size of the pulmonary embolism were factors used in determination of whether the patient received either one or two catheters and whether the catheter was placed intrathrombus or proximal to the thrombus to deliver the lytic. Of the thirty five procedures analyzed, nineteen procedures were performed utilizing a single catheter (54%) and sixteen procedures performed using dual catheters (46%) (Table 1). Sixteen of the subjects had their catheter(s) embedded within the thrombus (intrathrombic) for delivery of the lytic agent (46%); 18 of the subjects had their catheters placed proximal to the thrombus (51%); and one patient underwent both methods (3%) (Table 2).

Duration of the procedure was coded as ≤ 12 hrs = 1; 13-24 hrs = 2; 25-36 hrs = 3; 37-48 hrs = 4; ≥ 49 hrs = 5 (Table 3). Six patients had CDT that lasted for less than or equal to twelve hours (17%) , sixteen patients had CDT that lasted for a duration of 13-24 hours (46%), three patients had CDT that lasted for 25-36 hours (9%), four patients had CDT that lasted for

37-48 hours (11%), and six patients had CDT that lasted for greater than equal to 49 hours (17%).

Five of the thirty five subjects had a history of right ventricular dysfunction (RVD) prior to the procedure (14%). Of the five patients with RVD, three patients had -5 or less mmHg change in their systolic PA pressure, one patient had a change of -11mmHg, and the last patient had a change of -20 mmHg.

Difference in systolic pulmonary arterial pressure pre and post CDT was also evaluated coded as (0) no change in pressure to a change or -5mmHg, (-1) change or -5 to -15 mmHg, (-2) change of greater than or equal to 16mmHg. Ten subjects had no change (28%) , seventeen subjects had a change -5 to -15 mmHg (49%) , six subjects had a change of greater than or equal to -16 mmHg (17%) and two subjects did not receive a difference in PA pressure due to either an initial or final recording of PA pressure that was unable to be recorded (6%) (Table 4). All patients experienced a decrease in systolic PA pressure.

Data Analysis

1. No significant relationship was identified between the type of catheter (single or dual) and

   A. the duration of the thrombolytic procedure

   B. the presence of pre-procedural right ventricular dysfunction (RVD)

   C. the change in pre and post systolic pulmonary artery pressure

A point bi-serial test was used to evaluate the relationship between the independent variable, number of catheters, and the dependent variable, duration of treatment resulting in R = -0.192 (Table 5). The critical value is .349 at a two-tailed test with a level of significance = 0.05, with a magnitude of -.192 in a negative direction. (Ary, Jacobs, Razavieh, 1979). This

suggests a slight association with longer procedure times associated with the use of a single catheter. However, no significant correlation was identified between the number of catheters and the duration of treatment (p=0.05).

A point bi-serial test was used to evaluate the relationship between the independent variable, number of catheters, and the independent variable, change in pulmonary artery pressure resulting in R = -.005 (p = 0.05), with a magnitude of -.005 in a negative direction. The results of this test showed no significant correlation between the number of catheters and the change in pulmonary artery pressure (Table 6).

Contingency table measures of association were used to examine dual versus single tip catheters and the presence of pre procedural Right Ventricular Dysfunction. Results were reported as phi coefficients. Phi =.211 at a significance level of 0.05. The results of the contingency tables also showed no significant correlation (Table 7 & 8).

2. No significant relationship was identified between method of thrombolytic agent instillation (external or embedded) and

A. the duration of the thrombolytic procedure

B. the presence of pre-procedural right ventricular dysfunction (RVD)

C. the change in systolic pre and post pulmonary artery pressure

A point bi-serial test was used to evaluate the relationship between the independent variable, catheter placement, and the dependent variable, duration of treatment resulting in an R = .068. This is less than the critical value of .349 for a 0.05 level of significance with a magnitude of .068 in a positive direction. Therefore, no significant correlation was identified between the placement of the catheter and the duration of treatment (Table 9).

A point bi-serial test was used to evaluate the relationship between the independent variable, catheter placement, and the dependent variable, change in systolic pulmonary artery pressure. The results of this test demonstrated R = -.297 with a negative direction with a magnitude of -.297. The results suggest a slight association noting a greater change in systolic PA pressure when the catheter was placed intrathrombically. However, a significant relationship was not identified between the placement of the catheter and the change in pulmonary artery pressure (Table 10).

Contingency table measures of association were used to examine embedded catheters versus non-embedded catheters and the presence of pre-procedural Right Ventricular Dysfunction. This statistical analysis resulted in Phi =- .133, with a magnitude of -.133 in a negative direction, indicating no significant correlation between these variables (Table 11 & 12).

Qualitative Data

Of the 35 patients studied 25 had no noted immediate complications. Of the 10 patients that did have complications five patients had post procedural pulmonary hypertension, two patients had mild thrombocytopenia, one patient had a significant hematoma, one patient had a headache (negative for intracranial hemorrhage), and one patient had left cerebral intracranial hemorrhage within one hour post completion of tPA and removal of catheter. Of the ten patients that experienced immediate complications, 70% had only a single catheter delivering the lytic to their pulmonary embolism. In addition, 70% of the patients experiencing complications also had the catheter(s) placed proximal to the thrombus to deliver the lytic. Please note that although the percentages are the same, the population was analyzed as a

separate data set for type of catheter and method of lytic administration. Therefore, the results yielded two distinct patient data sets specific to the independent variable.

Limitations/ Suggestions for Further Research

There were a few limitations to this study. The major limitation of this study included a small sample size. After eliminating the 14 patients that did not meet the criteria from the original convenience sample of 49, only 35 patients remained. This is a problem because as the sample size increases, the power of the statistics increases. Sample sizes of a minimum of 20 should be used when analyzing data using parametric statistics. Also, the sample of patients that we did study was only from a small period of time, one year. A longitudinal study would provide additional data about long term complications, including whether presence of RVD remained or returned post procedure. Another limitation that was encountered was that when searching for the data, there were some instances where the data had not been recorded. Suggestions for further research would include a longitudinal study of a larger sample size, preferably with at 20-30 individuals in each group studied.

Discussion

There is limited, current literature regarding effectiveness and advantages associated with the delivery of a lytic agent utilizing multiple catheters for pulmonary embolism. In cases of DVT, dual catheters used to deliver the lytic agent directly to the thrombus suggested a decrease the duration of the thrombolytic procedure (Vedantham, Milward, Cardella, et al., 2006). Although a small negative correlation is noted in this study suggesting a slight association with longer procedure times related to the use of a single catheter to deliver lytic to the thrombus, no significant correlation was identified between the number of catheters used and the duration of the thrombolytic procedure.

Also, according to literature, the use of multiple catheters increases the chance of post procedural complications (Vedantham, Milward, Cardella, et al., 2006). Some of the main complications associated with the use of multiple catheters include vessel spasm, incision site hematomas, and non-cerebral hemorrhage (Vedantham, Milward, Cardella, et al., 2006). These findings were not supported by the data analyzed in this study. Out of the ten subjects that experienced complications, seventy percent underwent CDT with only one catheter. Also, out of the three patients who had catheter directed thrombolysis with two catheters and experienced complications, one developed mild thrombocytopenia, and the other two developed post procedural pulmonary hypertension. None of the patients experienced the major complications mentioned in the literature.

Literature reviewed regarding the use of catheters embedded within the embolism demonstrates better outcomes when this technique is utilized in intracranial thrombolytic procedures (Jungreis, Wechsler, & Horton, 2010). Potential risks associated with embedding the

catheter include arterial rupture, injury of the perforating artery and spasm (Ikushima, Ohta, Hirai, et al, 2007). The systemic effects of the thrombolytic agents are minimized when the catheter is embedded into the thrombosis resulting in a decrease of hemorrhages when compared to systemic intravenous administration (Jungreis, Wechsler, & Horton, 2010). This study supported the findings demonstrated by Jungreis, Wechsler, and Horton (2010). The analysis of the data collected for this study identified that 70 percent of the patients with complication had the lytic agent delivered proximal to the thrombus. Although, the complications recorded from this study showed there were no reported cases of artery perforation or spasm. Only one case of hemorrhage was reported out of all 38 cases.

Research conducted by Castro (1999) suggested that when the catheter is embedded within the clot, the duration of the infusion should be decreased dramatically as opposed to infusing the thrombolytic agent through a catheter placed proximal to the clot (Castro, 1999). However, this study did not support Castro's (1999) findings because the analysis of the data indicates similar procedure times for both methods of catheter placement during thrombolysis.

Conclusion

The analysis of this dataset demonstrates that all four CDT options are equally effective in this convenience sample. The data indicates that there were no significant correlations identified between the independent variables of catheter placement and number of catheters and the dependent variables of duration of treatment change in systolic pulmonary artery pressure and presence of pre-procedural right ventricular dysfunction.

1. No significant relationship was identified between the type of catheter (single or dual) and

    A. the duration of the thrombolytic procedure

    B. the presence of pre-procedural right ventricular dysfunction (RVD)

    C. the change in pre and post systolic pulmonary artery pressure

2. No significant relationship was identified between method of thrombolytic agent instillation (external or embedded) and

    A. the duration of the thrombolytic procedure

    B. the presence of pre-procedural right ventricular dysfunction (RVD)

    C. the change in pre and post systolic pulmonary artery pressure

It is important to note that the small sample size used in this study significantly limits the power of the statistical analysis and the generalizability of these findings. However, these findings do support similar findings in current research as identified through a thorough literature search. The current studies indicate that there still seems to be no definitive method for performing catheter-directed therapy (CDT).

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Appendix

Table 1: Frequency-Placement of the Catheter

	Frequency	Percent
Intrathrombic	16	46
Proximal to the thrombus	18	51
One catheter of each	1	3
Total	35	100

Table 2:
Frequency- Number of Catheters

	Frequency	Percent
Single	19	54.3
Dual	16	45.7
Total	35	100

Table 3:
Frequency- Duration of CDT

	Frequency	Percent
Less than or equal to 12 hours	6	17.1
13-24 hours	16	45.7
25-36 hours	3	8.6
37-48 hours	4	11.4
Greater than or equal to 49 hours	6	17.1
Total	35	100

Table 4:
Frequency- Systolic Pulmonary Artery Pressure Difference

	Frequency	Percent
No Change	10	28
Change of -5 to -15 mmHg	17	49
Less than or equal to -16 mmHg	6	17
Incomplete PA pressure recordings	2	6
Total	35	100

Table 5:
Correlation- Catheter Type and duration of treatment

		Duration
Catheter Type	Pearson Correlation	-.192
	Sig. (2 tailed)	.270
	N	35

Table 6:

Correlation- Catheter Type and Systolic PA pressure difference

		PA Pressure diff
Catheter Type	Pearson Correlation	-.005
	Sig. (2-tailed)	.976
	N	33

Table 7:
Catheter type- RVD Crosstabulation

			RVD-Yes	RVD-No	Total
Catheter Type	Single	Count	4	15	19
		% within catheter type	21.1%	78.9%	100%
		%with RVD	80.0%	50.0%	54.3%
	Dual	Count	1	15	16
		% within catheter type	6.3%	93.8%	100.0%
		%with RVD	20.0%	50.0%	45.7%
Total		Count	5	30	35
		% within catheter type	14.3%	85.7%	100.0%
		%with RVD	100.0%	100.0%	100.0%

Table 8:

Correlation- Catheter type-RVD

		Value	Approx. Sig.
Nominal by Nominal	Phi	.211	.213
N of Valid Cases		35	

Table 9:
Correlation- Placement of Catheter and Duration

		Duration
Placement	Pearson Correlation	.068
	Sig. (2 tailed)	.704
	N	34

Table 10:

Correlation- Placement of Catheter and Systolic PA pressure difference

		PA pressure diff
Placement	Pearson Correlation	-.297
	Sig. (2 tailed)	.098
	N	32

Table 11:
Catheter Placement-RVD Crosstabulation

			RVD-Yes	RVD-No	Total
Placement	intrathrombic	Count	1	11	12
		% within placement	8.3%	91.7%	100.0%
		%with RVD	20.0%	37.9%	35.3%
	Proximal to the thrombus	Count	4	18	22
		% within placement	18.2%	81.8%	100.0%
		%with RVD	80.0%	62.1%	64.7%
Total		Count	5	29	34
		% within embedded	14.7%	85.3%	100.0%
		%with RVD	100.0%	100.0%	100.0%

Table 12:

Correlation- Catheter type-RVD

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.133	.438
N of Valid Cases		34	