

Estimated Cost of Fibrin Glue in Literature is \$122 per mL

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Objectives: The purpose of this study is to systematically investigate the current cost/mL of fibrin glue used in the operating room based on currently published literature.

Design: Systematic literature review.

Main Outcome Measurements: Cost in dollars per milliliter.

Results: A literature search produced 500 articles regarding “Fibrin Glue Cost,” of which 18 had novel estimates for the cost of fibrin glue per mL. The average cost estimate for fibrin glue in the current literature is \$161.61 ± \$140.78. With outliers removed, it was \$122.45 ± \$61.90.

Conclusions: Fibrin glue is used in many procedures for its hemostatic, adhesive, and sealant properties. In this literature review study, the average cost of fibrin glue was \$161.61/mL, with indications that the true cost may be significantly cheaper. It is a financially stable option that has become relatively inexpensive since it came into practice. Future studies are needed to investigate the overall cost-benefit analysis.

Level of Evidence: Level IV; Systematic Review of level IV or higher evidence

Key Words: Business, management, human resources, cost, value, efficiency

INTRODUCTION

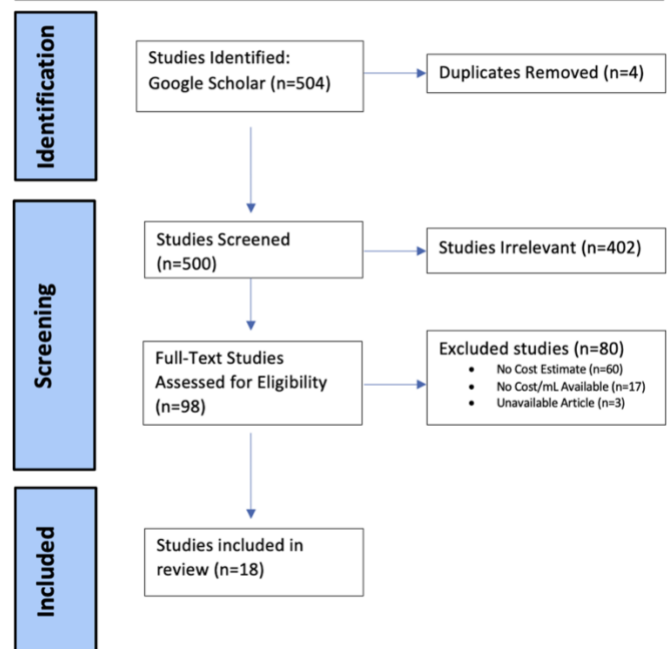
Fibrin glue is used in many procedures and mimics the blood clotting cascade¹. It consists of concentrated human fibrinogen, factor XIII, and other plasma proteins activated by adding bovine thrombin and calcium chloride². Thrombin converts fibrinogen to fibrin monomers, causing the mixture to gel. Concurrent stabilization occurs by factor XIII activation via thrombin, which crosslinks fibrin monomers, ultimately increasing the tensile strength of the clot². Ultimately, using Fibrin glue replicates the last wound healing phase, which involves converting fibrinogen to fibrin².

Gradual resorption of the sealant then occurs as the healing progresses.

Fibrin glue is diverse in its utilities, but its cost has yet to be well characterized. It is commonly used as a hemostatic, adhesive, and sealant agent³. It has been shown to reduce operating times and ultimately lead to a lower operation cost¹.

However, the exact cost of fibrin glue is not well known, has many determinants, and has many different estimates (4-21). The objective of this study is to determine the average cost of fibrin glue found in current literature, which can then be used in further cost-benefit analysis.

Figure 1: PRISMA flow diagram of studies from search through screening to inclusion and exclusion



METHODS

This systematic review was performed following PRISMA guidelines for methodology and reporting. Eligibility criteria were met if the study included the cost

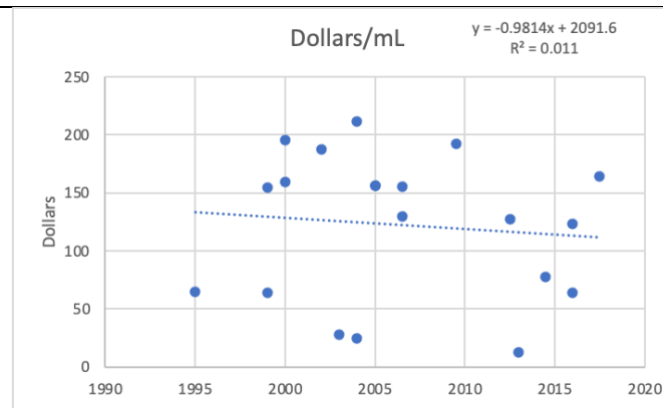
Table 1. Estimated cost/mL of Fibrin Glue from 18 Articles Yielding 22 Estimates in the Current Literature

Citation	Year	Total Cost estimation	\$/ml [year]	\$/ml [2023]	Median
Bracale U, et. al	2009-2010	98 Euros/ml	141.18-130.95	201.14-183.82	192.48
Christenson JT, et. al	2004	96/ml (euros)	130.76	211.41	211.41
Christenson JT, et. al	2004	11/ml (euros)	14.98	24.22	24.22
Wong K, et. al	1994-1996	130 Euros/ 5ml	32.39-32.74	66.57-63.51	65.04
Machen GL, et. al	2007-2016	\$465/5ml	93-93	136.23-118.52	127.38
Carter MJ. et. al	2016	\$388.08/4ml	97.02	123.64	123.64
Pilon F, et. al	2005-2008	\$170/2ml or \$434/5ml	85 or 86.8	132.89-124.40 or 135.70-127.03	130.01
Weatherall JM, et. al	2002-2010	\$100/ ml	100	170.08-140.37	155.23
Lovisetto F, et. al	2005	\$500/5 mL	100	156.34	156.34
Rhemtulla IA, et. al	2015-2017	\$50/mL	50	65.04-62.40	63.72
Marchac D, et. al	2005	\$500 5 mL	100	156.34	156.34
Novik, B., et. al	2000	\$230/2ml	115	195.59	195.59
Novik, B., et. al	2000	\$450/5ml	90	159.14	159.14
Ferrarese, et. al	2014-2015	€ 259/5mL	62.89-56.39	82.40-73.35	77.88
Delhi J	2009-2017	1000 INR /2 mL	10.78-7.83	15.36-9.77	12.57
Ramachandran R, et. al	2015-2020	7000-11000 INR /ml	105.81-95.8, 166.28-150.55	137.64-124.62, 216.30-177.83 191.53-183.63	164.09
Johnson L, et. al	2001-2003	\$220/2-ml	110	191.53-183.63	187.58
Daneshrad P, et. al	2003	\$100/6ml	16.67	27.83	27.83
Khalid AQ.	2009	\$350/mL	350	498.66	498.66
Reiner AP.	1999	\$665/2mL	332.5	607.85	607.85
Reiner AP.	1999	\$70/2mL	35	63.98	63.98
Reiner AP.	1999	\$180/2mL	90	154.53	154.53
				Mean Cost	161.61
				St Dev	140.78
				Median Cost	154.88

of fibrin glue. The article's eligibility was not limited by study design. Studies were excluded if no fibrin glue cost was reported or there was no way of accessing the article.

The search was performed in Google Scholar via Harzing PoP software version 815 for the following keywords: (cost of fibrin glue). Results were not limited by year.

All results were cataloged and independently reviewed by the authors. In the first phase, study titles and abstracts were screened by one author. In the second phase, the full texts of articles that met the inclusion criteria were reviewed. Data including year, total cost estimation, cost/ml, fibrin glue brand, type of surgery, and location were then extracted from these articles. Extracted currency values were first converted to US

Figure 2: Cost Trend with Outliers Removed.

dollars using conversion rates for December of the reported year. Next, inflation of the US dollar was factored in, and the final US dollar cost estimation/mL was based upon US dollar values as of October 2023. For cost estimations provided from studies over a period of years, a range was established with the endpoints correlating to the US dollar value for the first and last year of the reported time frame. Once the final 2023 US dollar value range was obtained, the median of the range was taken to report a single 2023 US dollar/mL value. When multiple total cost estimations were given over a range of years, the same method was used to obtain a range from each cost estimation, after which the median was obtained.

An independent online historical currency converter was used to convert the different currencies to US dollars. The online CPI inflation calculator provided by the US Bureau of Labor Statistics was used to account for US inflation.

RESULTS

The search criteria yielded 504 articles, including 4 duplicates subsequently removed. 500 articles were then eligible for and underwent title and abstract screening. Of these articles, 402 were determined to be irrelevant, and 98 were eligible for full-text review. 63 were excluded during the full-text review, ultimately leaving 35 articles with an estimation

of cost. Of these, only 18 studies provided give a cost per mL and were included (Figure 1).

Additionally, three studies provided multiple cost estimates. These compared different brands, kits, or methods, and 22 distinct cost estimates were therefore used to calculate the estimated cost/mL and standard deviation.

Using the value of the US dollar as of October 2023 to adjust for currency conversion and inflation, the average cost of fibrin glue/mL was found to be \$161.61/mL, with a standard deviation of 140.78. The sample's median value is 154.88 (Table 1).

Significant outliers were noted in the included initial data, so they were excluded for subsequent post-hoc analysis. When excluded from the data set the average and standard deviation adjust down to \$122.45 and 61.90, respectively.

When the outliers are excluded, the slope is -0.98 with an R squared value equal to 0.011, denoting that the overall cost of fibrin glue is trending downwards (Figure 2).

DISCUSSION

Fibrin glue mimics the clotting cascade, acting as a hemostatic agent in addition to its adhesive and sealant properties. This makes it a valuable tool during various procedures. Based on our current findings, the mean cost of fibrin glue was \$161.61/mL. With outliers excluded, the mean cost was found to be \$122.45/mL.

The data set's mean is greater than the median, suggesting a skewed data set. Further investigation led to a box-and-whisker plot that revealed two cost-estimate outliers. The higher values are more than three standard deviations above the mean, and the lower is more than two. Excluding these values revealed a new mean of \$122, which may be a better estimate of the true cost of fibrin glue.

The data also reveals that fibrin glue has not increased in cost over the last twenty years. In fact, after

adjusting for inflation, the cost decreases over time. Many factors drive the cost, including the supply and demand principle. Since its approval by the FDA in 1998, fibrin glue has become more accessible with decreased costs²².

Further studies are needed to investigate the overall costs associated with fibrin glue. This information can then be integrated to tailor patient care and best fit the patient's needs.

CONCLUSION

Fibrin glue is used in many procedures for its hemostatic, adhesive, and sealant properties. In this literature review study, the average cost of fibrin glue was \$161.61/mL, with indications that the true cost may be significantly cheaper. It is a financially stable option that has remained relatively inexpensive since it came into practice. Future studies are needed to investigate the overall cost-benefit analysis for Fibrin glue utilization.

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