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ADDENDUM 1: PNRc ENROLLING CENTERS

Nationwide Children's Hospital and The Ohio State University, Columbus, OH: J Mahan, H Patel, RF Ransom

Medical College of Wisconsin, Milwaukee, WI: C Pan

The Hospital for Sick Children, Toronto, ON: DF Geary

West Virginia University, Charleston, WV: ML Chang

University of North Carolina, Chapel Hill, NC: KL Gibson

Louisiana State University, New Orleans, LA: FM Iorembor

University of Iowa Stead Family Children's Hospital, Iowa City, IA: PD Brophy

Children's Mercy Hospital, Kansas City, MO: T Srivastava

Emory University School of Medicine, Atlanta, GA: LA Greenbaum

ADDENDUM 2: NEPTUNE ENROLLING CENTERS

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Children's Hospital, Los Angeles, CA: K Lemley*, J Scott#
Children's Mercy Hospital, Kansas City, MO: T
Srivastava*, S Morrison# *Cohen Children's Hospital,*
New Hyde Park, NY: C Sethna*, M Pfai# *Columbia*
University, New York, NY: P Canetta*, A Pradhan#
Emory University, Atlanta, GA: L Greenbaum*, C Wang**, E Yun#
Harbor-University of California Los Angeles Medical Center: S
Adler*, J LaPage# *John H. Stroger Jr. Hospital of Cook County,*
Chicago, IL: A Athavale*, M Itteera *Johns Hopkins Medicine,*
Baltimore, MD: M Atkinson*, T Dell#
Mayo Clinic, Rochester, MN: F Fervenza*, M Hogan**,
J Lieske*, G Hill# *Montefiore Medical Center, Bronx,*
NY: F Kaskel*, M Ross*, P Flynn# *NIDDK Intramural,*
Bethesda MD: J Kopp*
New York University Medical Center, New York, NY: L Malaga-Diequez*, O Zhdanova**,
F Modersitzki#, L Pehrson#
Stanford University, Stanford, CA: R Lafayette*, B Yeung#
Temple University, Philadelphia, PA: I Lee*, S Quinn-Boyle#
University Health Network Toronto: H Reich*, M Hladunewich**, P Ling#, M Romano#
University of Miami, Miami, FL: A Fornoni*, C Bidot#
University of Michigan, Ann Arbor, MI: M Kretzler*, D Gipson*, A Williams#, C Klida#
University of North Carolina, Chapel Hill, NC: V Derebail*, K Gibson*, A
Froment#, F Ochoa-Toro# *University of Pennsylvania, Philadelphia, PA:* L
Holzman*, K Meyers**, K Kallem#, A Swenson# *University of Texas*
Southwestern, Dallas, TX: K Sambandam*, K Aleman#, M Rogers#
University of Washington, Seattle, WA: A Jefferson*, S Hingorani**, K Tuttle**§, L
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Wake Forest University Baptist Health, Winston-Salem, NC: JJ Lin*, Stefanie Baker#

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H Desmond, S Eddy, D Fermin, M Larkina, S Li, S Li, CC Lienczewski, T Mainieri, R Scherr,
A Smith, A Szymanski, A Williams.

Digital Pathology Committee: Carmen Avila-Casado (University Health Network, Toronto),
Serena Bagnasco (Johns Hopkins University), Joseph Gaut (Washington University in St
Louis), Stephen Hewitt (National Cancer Institute), Jeff Hodgins (University of Michigan), Kevin
Lemley (Children's Hospital of Los Angeles), Laura Mariani (University of Michigan), Matthew
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Royal (University of Montreal), David Thomas (University of Miami), Jarcy Zee (University of
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SUPPLEMENTAL MATERIALS AND METHODS

Study Participants

NEPTUNE Cohort

The composition of the Nephrotic Syndrome Study Network (NEPTUNE) has been described previously.¹⁻³ The study is registered at clinicaltrials.gov (NCT01209000) and each participant (or their parent/guardian) provided written, informed consent prior to participation. Participants were enrolled from 24 clinical sites in North America with local IRB approval at each institution. Briefly, adults and children with nephrotic-range proteinuria (≥ 500 mg/d on a 24 h urine sample or urinary protein-to-creatinine (UP:C) ratio ≥ 0.5 g/g on spot urine) were eligible for enrollment at the time of a first clinically indicated kidney biopsy. Because kidney biopsy at presentation is not the standard of care in pediatrics, children (≤ 18 years) were also eligible for enrollment based upon the above proteinuria criteria alone. Exclusion criteria included life expectancy < 6 months, prior solid organ transplantation, and kidney manifestations of systemic disease. For the purposes of the present study, participants with a recorded prescription for anticoagulant or antiplatelet medications were excluded. Participants with a pre-enrollment history of VTE were also excluded from this study to decrease potential confounding from non-NS hypercoagulable conditions. Participants' phenotypic data was collected from the NEPTUNE Data Coordinating Center database (transSMART). The NEPTUNE cohort consisted of plasma samples from 150 unique subjects randomly selected to represent the available proteinuria spectrum within the NEPTUNE biorepository as of October 2014 (including patients with active disease as well as those who had achieved partial or complete remission). Three (2%) samples had undetectable thrombin generation indicating that the plasma had clotted during the pre-analytic phase; the remaining 147 samples were thus included in this study.⁴

PNRC Cohort

Children with incident NS were recruited from Pediatric Nephrology Research Consortium (PNRC) participating centers. As described previously, the study protocols and consent documents were approved by the Nationwide Children's Hospital Institutional Review Board (IRB05-00544, IRB07-004, & IRB12-00039) and at each participating PNRC center.⁵ Participants were enrolled between 2008-2014 and their samples were banked at

Nationwide Children's Hospital until analyzed. Glucocorticoid (GC) therapy naïve children 1-18 years of age presenting with edema and proteinuria $\geq 3+$ by dipstick were eligible for enrollment.

Columbus Cohort

Participants with incident nephrotic syndrome were subject to the same eligibility criteria as the NEPTUNE participants, including exclusion for pre-enrollment VTE history, anticoagulant, or antiplatelet medications.⁴ Samples were collected at diagnosis prior to initiation of any nephrotic syndrome-directed therapy. Participants were enrolled between 2013-2015 and their samples were banked at Nationwide Children's Hospital until analyzed. This portion of the study was approved by the Nationwide Children's Hospital Institutional Review Board (IRB12-00290) in reciprocity with The Ohio State University Wexner Medical Center IRB. Written informed consent was obtained from each participant or parent/guardian.

Plasma Samples

Aliquots (≤ 200 μL) of plasma isolated from blood collected into 0.105 M buffered sodium citrate tubes (0.32% final concentration citrate) were provided by the NEPTUNE biorepository. Blood from the PNRC cohort was collected into 0.1 M sodium citrate cell preparation tubes containing a cell separator system (BD Vacutainer CPT (REF 362761) Becton, Dickinson and Company, Franklin Lakes, NJ) at an 8:1 blood-to-citrate ratio ($\sim 0.33\%$ final concentration NaCitrate). For the Columbus Cohort, blood was collected into final concentration 0.32% sodium citrate / 1.45 μM corn trypsin inhibitor (Haematologic Technologies Inc., Essex Junction, VT, USA) and platelet poor plasma (PPP) was prepared as previously described, aliquoted, and frozen at -80°C until further analysis.⁶

Supplemental Table 1: Key elements of studies included in meta-analyses

First Author	Publication Year	Study Design	Patients (N)	Age Range (Years)	Antithrombin Assay(s)	Nephrotic Features
Adult Studies (Majority of Patients >18 years)						
Thomsom et al ⁸	1974	CCSC	16	14-65	Activity	Proteinuria (>5 g/d); hypoproteinemia
Gomperts et al ⁹	1977	CCSC	5	19-38	Both Activity and Antigen	Proteinuria (>5 g/d); hypoalbuminemia (<3.5 g/dl)
Thaler et al ¹⁰	1978	CCSC	14	9-70	Both Activity and Antigen	Moderate to severe proteinuria (with histological diagnosis)
McGinley et al ¹¹	1983	CCSC	21	39.4±3.6	Activity	Proteinuria (>3 g/d); hypoalbuminemia (<3.5 g/dl)
Panicucci et al ¹²	1983	CCSC	20	“Adults”	Both Activity and Antigen	Moderate to severe proteinuria; hypoproteinemia
Vaziri et al ¹³	1984	CCSC	20	16-60	Both Activity and Antigen	Proteinuria (>3 g/d); hypoalbuminemia (<3.5 g/dl)
Mannucci et al ¹⁴	1986	CCSC	24	15-70	Both Activity and Antigen	Proteinuria (>3 g/d); hypoalbuminemia
Rydzewski et al ¹⁵	1986	CCSC	17	21-61	Antigen	Proteinuria (>3.5 g/d); hypoalbuminemia (<3.5 g/dl)
Hannedouche et al ¹⁶	1987	CCSC	15	42±18	Activity	Proteinuria (5.7±4.2 g/d); hypalbuminemia (2.19±0.72 g/dl)
Grandrille et al ¹⁷	1988	CCSC	10	16-82	Activity	Proteinuria (>2.5 g/d); hypoalbuminemia (<3.5 g/dl)
Grau et al ¹⁸	1988	CCSC	68	12-72	Both Activity and Antigen	Proteinuria (>2.5 g/d)
Mori et al ¹⁹	1988	CCSC	9	46-76	Both Activity and Antigen	Proteinuria (>4 g/d); hypoalbuminemia (<3.5 g/dl)
Toulon et al ²⁰	1992	CCSC	33	16-82	Both Activity and Antigen	Proteinuria (>3 g/d); hypoalbuminemia (<4 g/dl)
Joven et al ²¹	1997	CCSC	22	25-69	Antigen	Proteinuria (≥3.5 g/d); hypoalbuminemia (<3.1 g/dl)
Pediatric Studies (Majority of Patients ≤18 years)						
Boneu et al ²²	1981	CCSC	27	3-13	Both Activity and Antigen	Nephrotic features not specified

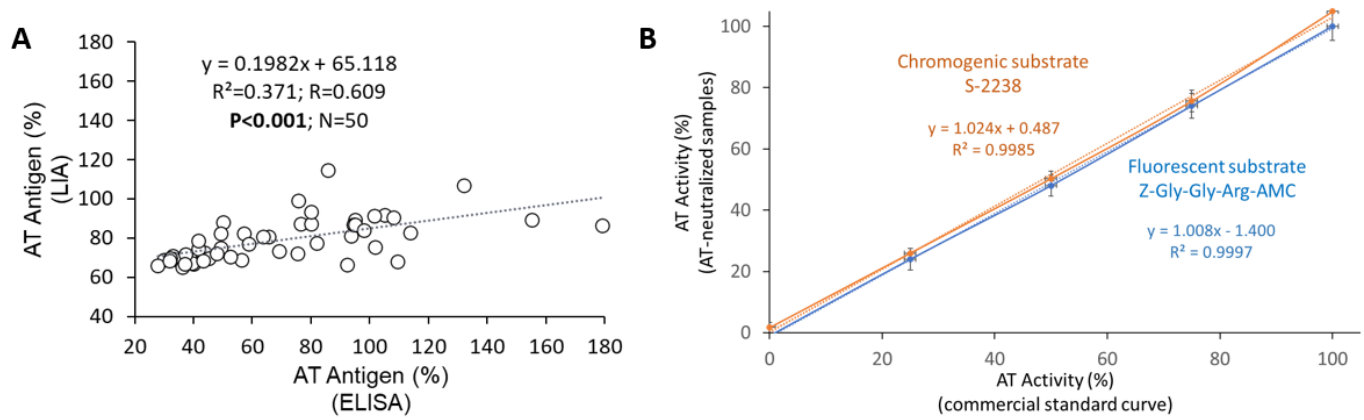
Elidrissy et al ²³	1985	CCSC	25	3-11	Activity	Proteinuria ($\geq 3+$ by dipstick or >40 mg/h/m ²); hypoalbuminemia (<2.5 g/dl)
Sie et al ²⁴	1988	CCSC	33	2-6	Activity	Proteinuria; hypoalbuminemia (<3.7 g/dl)
Fukui et al ²⁵	1989	CCSC	18	"Children"	Both Activity and Antigen	Nephrotic features not specified
Ueda et al ²⁶	1990	CCSC	23	3-16	Antigen	Proteinuria (3.4 ± 2.2 g/d); hypoalbuminemia (2.3 ± 0.5 g/dl)
Elidrissy et al ²⁷	1991	CCSC	39	2-14	Activity	Proteinuria ($\geq 3+$ by dipstick or >40 mg/h/m ²); hypoalbuminemia (<2.5 g/dl)
Andre et al ²⁸	1994	CCSC	29	1-14	Activity	Proteinuria; hypoproteinemia (<5.5 g/dl)
Yalcinkaya et al ²⁹	1995	CCSC	15	2.5-13	Activity	Proteinuria (>40 mg/h/m ²); hypoalbuminemia (<3 g/dl)
Al-Mugeiren ³⁰	1996	CCSC	41	2-14	Activity	Proteinuria (>40 mg/h/m ²); hypoalbuminemia (<2.5 g/dl)
Citak et al ³¹	2000	CCSC	49	1-16	Antigen	Proteinuria (>1 g/m ² /d); hypoalbuminemia (<2.5 g/dl)
Prandota et al ³²	2001	PCC	19	1.5-18	Activity	Proteinuria (151 ± 65 mg/kg/d); hypoalbuminemia (1.56 ± 0.5 g/dl)
Ozkayin et al ³³	2004	CCSC	26	2-15	Both Activity and Antigen	Proteinuria (>40 mg/m ² /hour); hypoalbuminemia
Mortazavi et al ³⁴	2008	CCSC	30	1.4-11	Antigen	Proteinuria (>1 g/m ² /d); hypoalbuminemia (<2.5 g/dl)

CCSC: Cross Sectional Case-Control; PCC: Prospective Case-Control

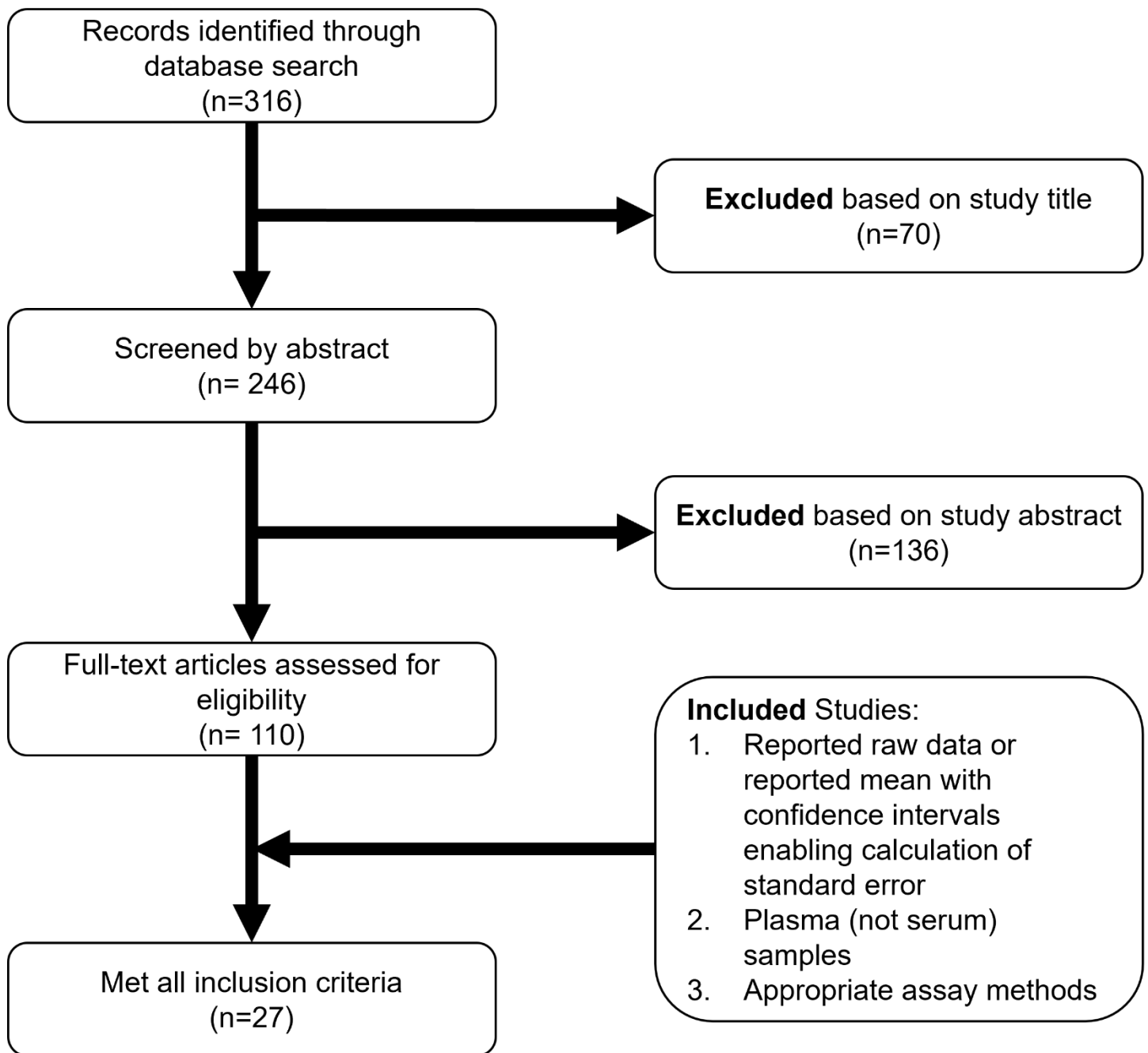
Supplemental Table 2: Newcastle-Ottawa scale risk-of-bias assessment for meta-analyses studies

First Author	Publication Year	Selection (/4)	Comparability (/2)	Exposure (/3)*	Total (/6)*
Adult Studies (Majority of Patients >18 years)					
Thomsom et al ¹⁸	1974	★★★★	0	N/A	3
Gomperts et al ¹⁹	1977	★★★★	★	N/A	5
Thaler et al ¹⁰	1978	★★★★	0	N/A	3
McGinley et al ¹¹	1983	★★★★	★★	N/A	5
Panicucci et al ¹²	1983	★★★★	0	N/A	4
Vaziri et al ¹³	1984	★★★★	★★	N/A	6
Mannucci et al ¹⁴	1986	★★★★	★	N/A	5
Rydzewski et al ¹⁵	1986	★★★★	★	N/A	5
Hannedouche et al ¹⁶	1987	★★★★	★	N/A	5
Grandrille et al ¹⁷	1988	★★★★	0	N/A	4
Grau et al ¹⁸	1988	★★★★	0	N/A	4
Mori et al ¹⁹	1988	★★★★	★	N/A	5
Toulon et al ²⁰	1992	★★★★	★	N/A	5
Joven et al ²¹	1997	★★★★	★	N/A	5
Pediatric Studies (Majority of Patients ≤18 years)					
Boneu et al ²²	1981	★★★★	★	N/A	5
Elidrissy et al ²³	1985	★★★★	★	N/A	5
Sie et al ²⁴	1988	★★★★	★	N/A	5
Fukui et al ²⁵	1989	★★★★	★	N/A	5
Ueda et al ²⁶	1990	★★★★	★	N/A	5
Elidrissy et al ²⁷	1991	★★★★	★★	N/A	6
Andre et al ²⁸	1994	★★★★	★	N/A	4
Yalcinkaya et al ²⁹	1995	★★★★	★	N/A	4
Al-Mugeiren ³⁰	1996	★★★★	★	N/A	4
Citak et al ³¹	2000	★★★★	★	N/A	4
Prandota et al ³²	2001	★★★★	★	N/A	4
Ozkayin et al ³³	2004	★★★★	★	N/A	4
Mortazavi et al ³⁴	2008	★★★★	★	N/A	4

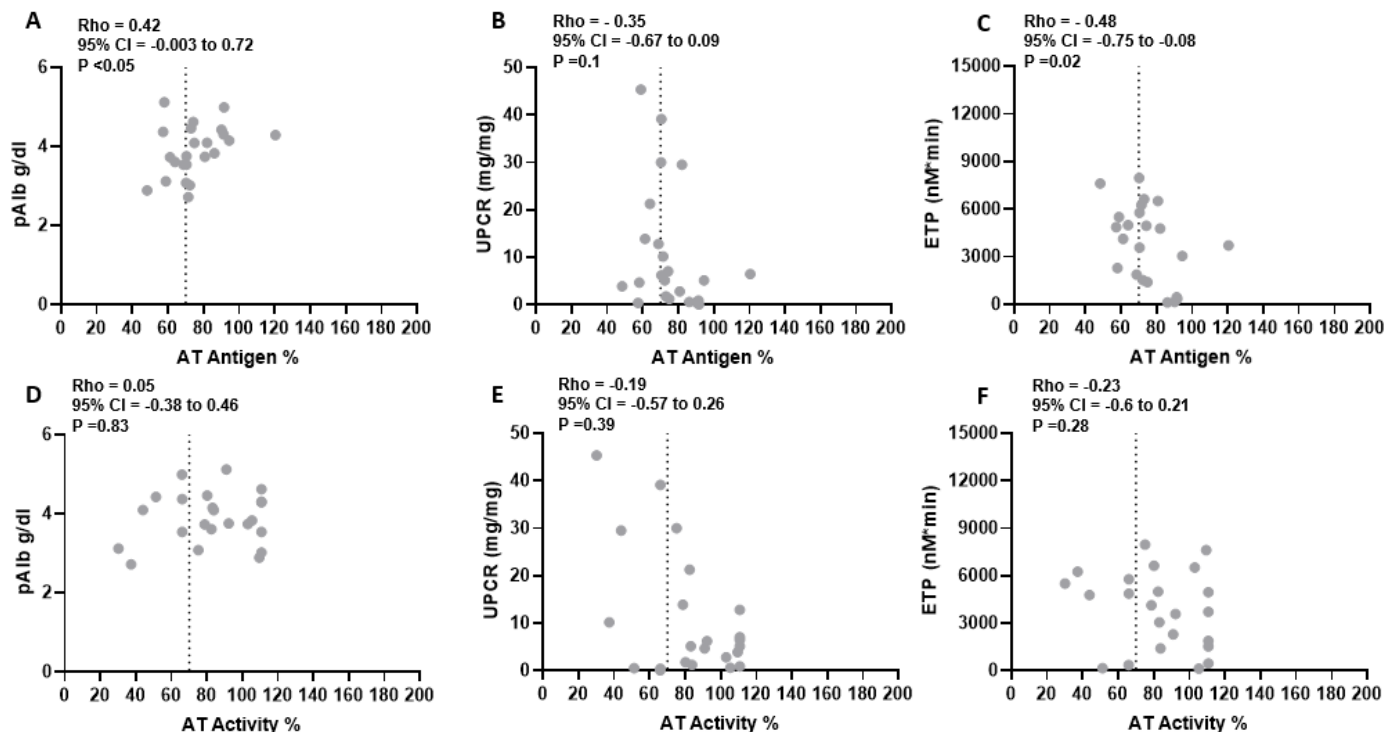
*The Newcastle-Ottawa scale defines exposure as an intervention. The studies included in these analyses were non-interventional.



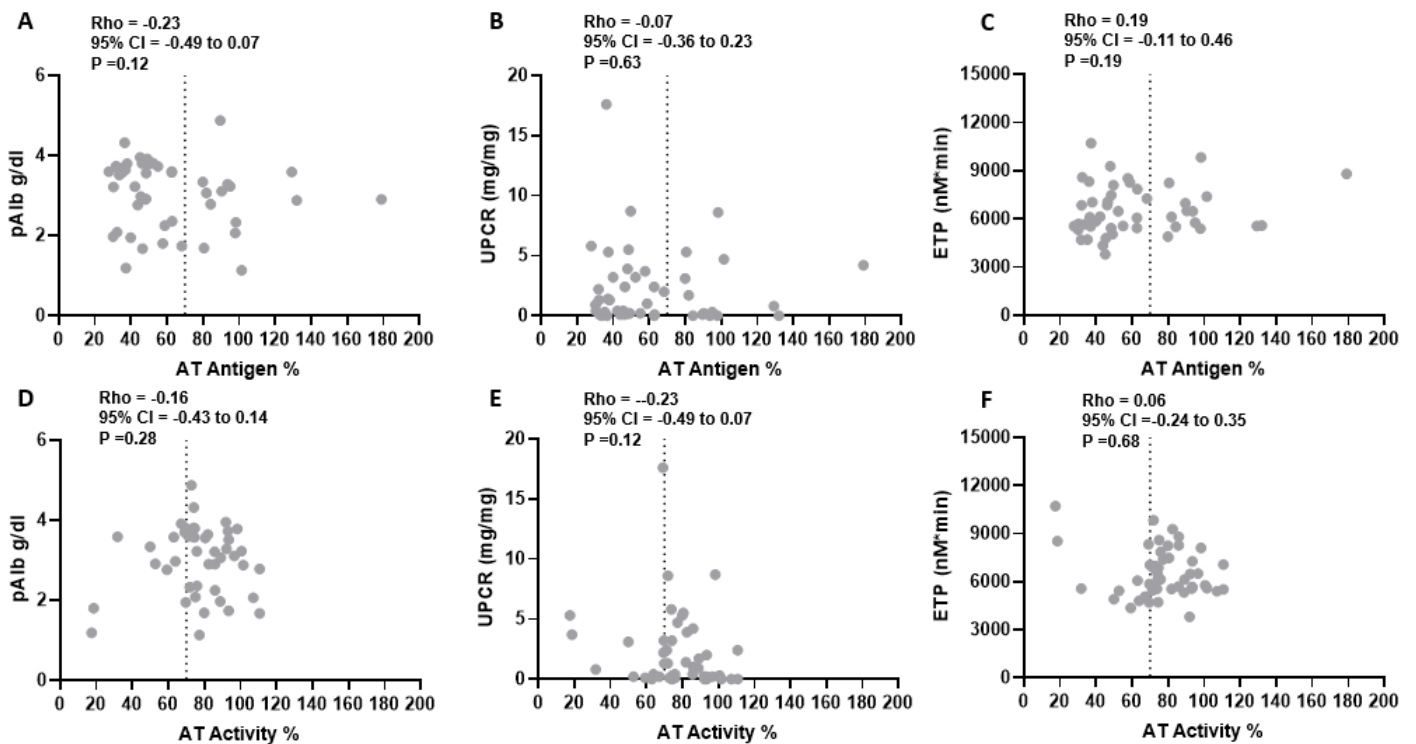
Supplemental Figure 1: Antithrombin Assay Validation. Antithrombin (AT) antigen quantification by latex immunoassay (LIA) and enzyme-linked immunosorbent assay (ELISA) were significantly correlated ($n=50$ NEPTUNE samples; **A**). Similarly, AT activity quantified using amidolytic assays with either chromogenic or fluorogenic reporters provided similar results (**B**). Two types of standard curve were utilized in **B**: On the x-axis standards were created with proportionate mixing of AT immunodepleted plasma and pooled normal plasma whereas the y-axis standards were generated with a set of healthy control plasmas treated with varying concentrations of AT neutralizing antibody ($n=3-4$ samples per point on the standard curve).



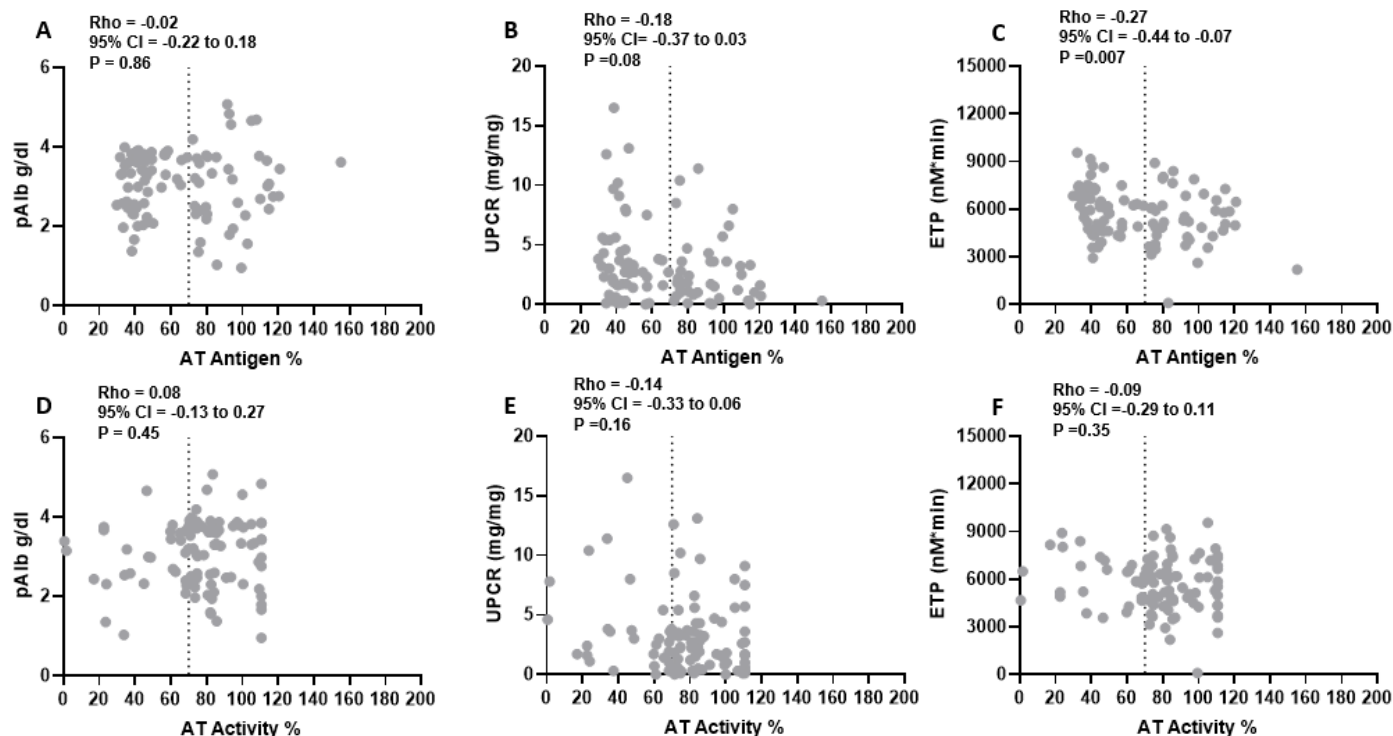
Supplemental Figure 2: Flow diagram illustrating exclusion and inclusion criteria of publications considered for the meta-analyses.



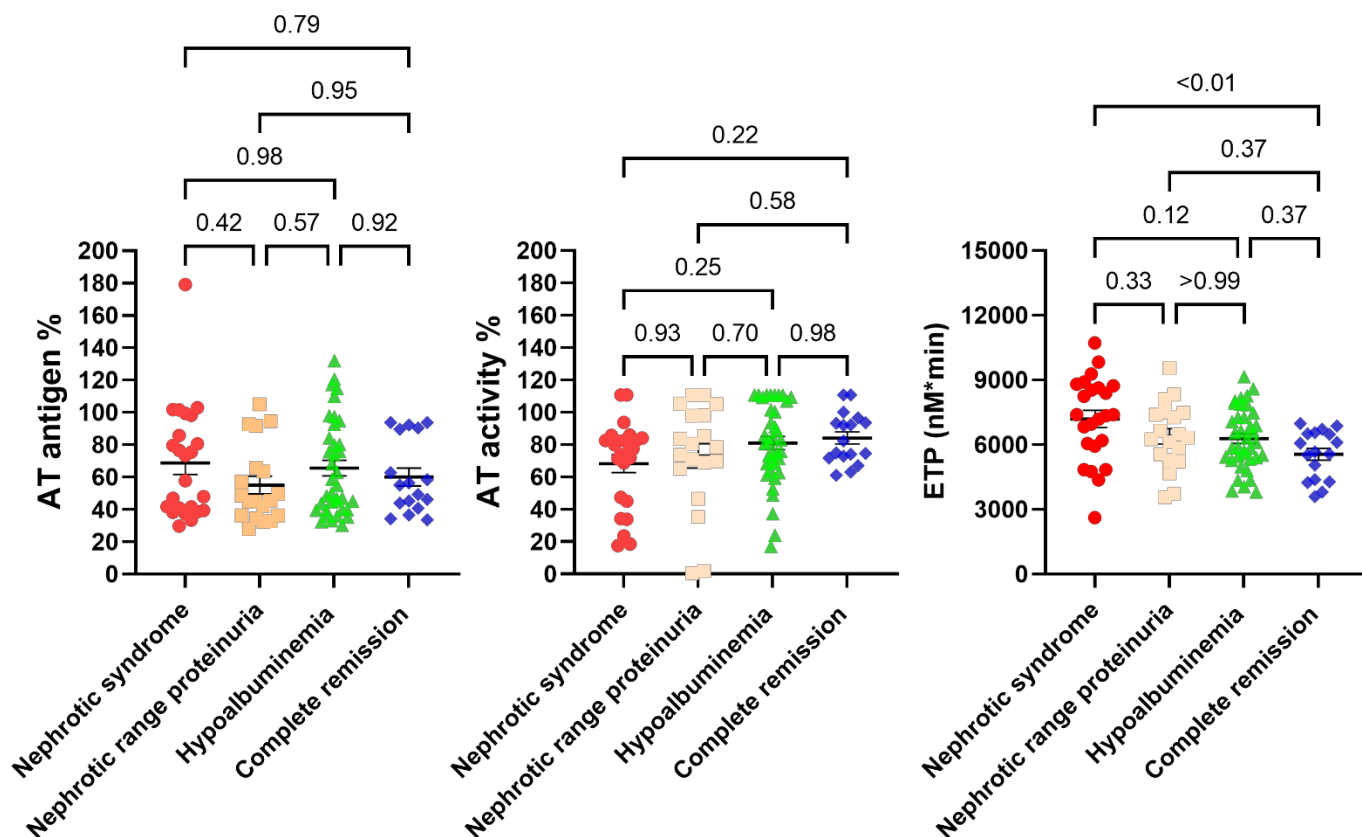
Supplemental Figure 3: Antithrombin relationships in the Columbus cohort. Antithrombin (AT) antigen was significantly correlated with plasma albumin (pAlb; **A**) and endogenous thrombin potential (ETP; **C**) but not with urinary protein-to-creatinine ratio (UPCR; **B**) in the Columbus cohort ($n=23$). AT activity was not significantly correlated with pAlb (**D**), UPCR (**E**), or ETP (**F**). The vertical dashed line in each panel represents 70% plasma AT, a commonly used threshold to define clinically relevant AT deficiency.



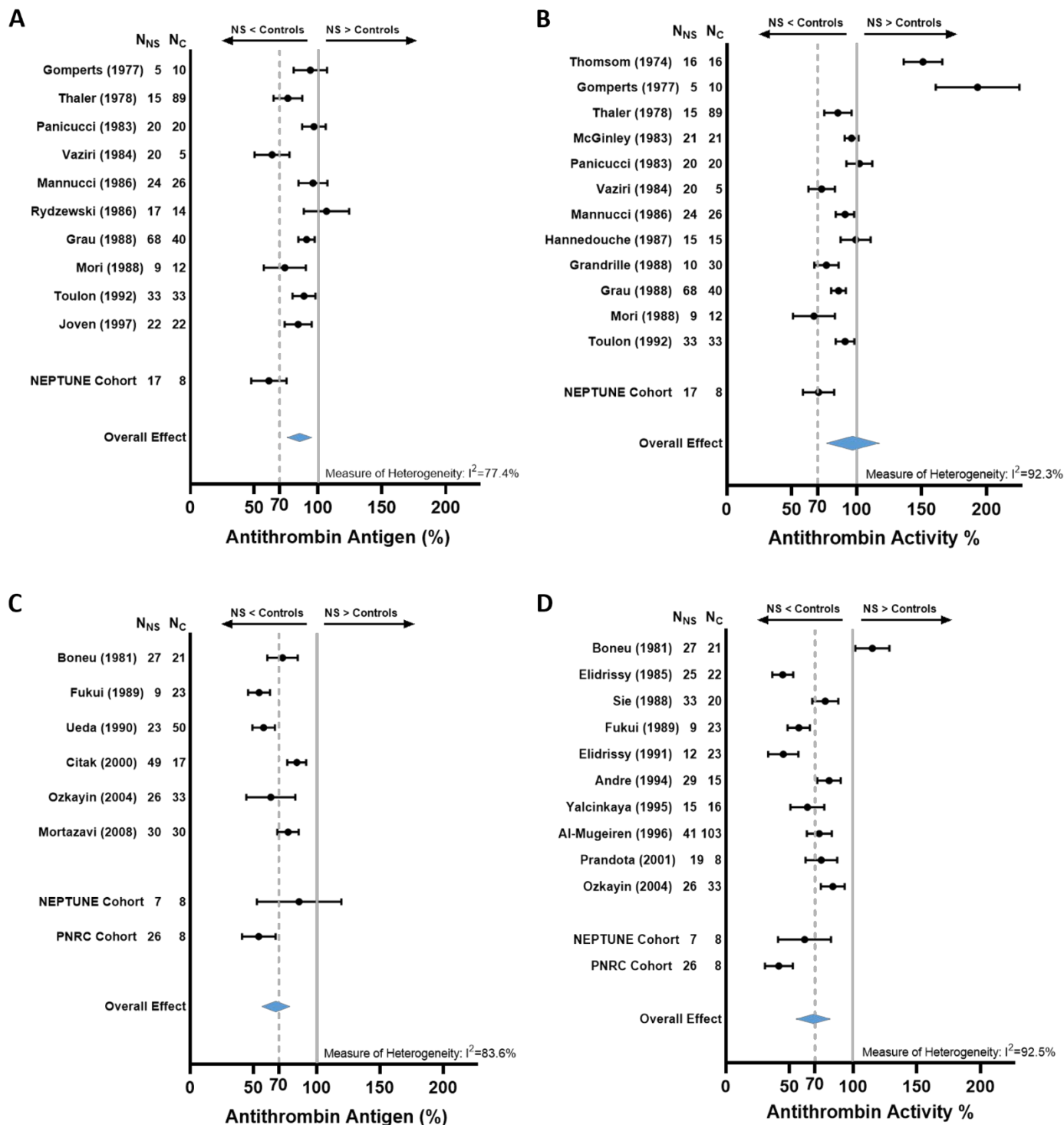
Supplemental Figure 4: Antithrombin was not correlated with hypercoagulopathy in the pediatric NEPTUNE subcohort. Neither antithrombin (AT) antigen (A, B, C) or activity (D, E, F) were correlated with plasma albumin (pAlb; A, D), urinary protein-to-creatinine ratio (UPCR; B, E), or endogenous thrombin potential (ETP; C, F) in the pediatric NEPTUNE subcohort ($n=47$). The vertical dashed line in each panel represents 70% plasma AT, a commonly used threshold to define clinically relevant AT deficiency.



Supplemental Figure 5: Antithrombin antigen was correlated with hypercoagulopathy in the adult NEPTUNE subcohort. Antithrombin (AT) antigen was correlated with endogenous thrombin potential (ETP; **C**) in the adult NEPTUNE subcohort ($n=100$). There was no significant correlation between AT activity and ETP (**F**) or between either AT antigen or activity with plasma albumin (pAlb; **A**, **D**) or urinary protein-to-creatinine ratio (UPCR; **B**, **E**). The vertical dashed line in each panel represents 70% plasma AT, a commonly used threshold to define clinically relevant AT deficiency.



Supplemental Figure 6: ETP changes with nephrosis activity whereas antithrombin antigen and activity do not. NEPTUNE patients were divided into the following sub-groups: Nephrotic syndrome (UPCR ≥ 3.5 g/g and albumin ≤ 3.0 g/dl; n=24), Nephrotic range proteinuria (UPCR ≥ 3.5 g/g and albumin > 3.0 g/dl; n=19), hypoalbuminemia (UPCR < 3.5 g/g and albumin ≤ 3.0 g/dl; n=37), and for comparison, “complete remission” (UPCR ≤ 0.3 g/g and albumin > 3.0 g/dl; n=17). **(A)** Antithrombin antigen was not significantly different amongst these groups. **(B)** Antithrombin activity was not significantly different amongst these groups. **(C)** Endogenous Thrombin Potential (ETP) was significantly decreased in the complete remission group compared to the nephrotic syndrome group.



Supplemental Figure 7: Antithrombin Deficiency was not a Uniform Feature of Nephrotic Syndrome. Based upon the overall effect estimates of these meta-analyses, clinically relevant antithrombin (AT) deficiency (<70%) was not expected in adults with active nephrotic syndrome (NS; **A**, **B**). AT deficiency was more likely to be observed in children with active NS but the confidence intervals for the overall effect estimates from these meta-analyses overlapped with normal AT values ($\geq 70\%$; **C**, **D**). The vertical dashed line in each panel represents 70% plasma AT, a commonly used threshold to define clinically relevant AT deficiency.

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