Lombardo

The Likelihood of Human Casualty in Highway Crashes

12th Briefing: Wide Scope Algorithm Evaluation

Based on an Investigation Conducted for
the FHWA/NHTSA Crash Analysis Center
at George Washington University, Virginia

October 28, 1996
DeBlois Associates
Washington, D.C.

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Introduction

This 12th briefing concerning the cited subject addresses the derivation and Evaluation of algorithms, from an "All Inclusive" to a most "Leaned", for the projection of compelling injury on the basis of crash scene observable data that serve as predictors. Several comparative evaluations are performed, including a comparison with the "Old Triage" algorithm.

Table I. Thirty Predictors Included in the "All Inclussive" Algorithm

INTERCPT	Intercept
OTHVEH0	Single Car Crash
OTHVEH1	Collision with Car or Light Vehicle
ROLL	Rollover Occurrence
GADF	Front Damage
GADS1	Side Center Damage
GADS2	Side End Damage
GADT	Top Damage
EXT1	Crush Extent 1
EXT2	Crush Extent 2
EXT3	Crush Extent 3
EXT4	Crush Extent 4
CURBWT	Car Curb Weight
LOSSINT	Loss of Integrity
INTRU	Intrusion (Front Seats)
SEATDISR	Seat Disruption
— RIMDEF	Rim Deformation
FIRE	Fire Occurrence
SEATF	Front Seating Pos.
— BELT	Belt Use
— BAG	Air Bag Deployment
— BEBA	Belt Use & Bag Deployment
OCCWT	Occupant Weight
— OCCHT	Occupant Height
AGE	Occupant Age
GENDER	Occupant Gender
ABNPOST	Abnormal Posture
ENTRAP	Entrapment
EJC	Complete Ejection
EJP	Partial Ejection
OTHRINJ	Other Seriously Injured Occ

All predictors are binary (1=Yes, 0=No), except:
Curb Weight in Hundreds of Pounds,
Occupant Weight in Pounds,
Occupant Height in Inches,
Occupant Age in Years, and
Intercept = Constant.

Certain, not explicitly stated predictors, assume implicit values. Specifically: If EJC=0 and EJP=0 then "No Ejection"; if OTHVEH0=0 and OTHVEH=1 then Collision is with Heavy Vehicle;
if GADF=GADS1=GADS2=GADT=0 then "Rear Damage";
if EXT1=EXT2=EXT3=EXT4=0 then "Crush Extent" = 4+;
if BELT=BAG=BEBA=0 then "No Restraint".

Table II. Four Predictors Eliminated by Backward Elimination, Leaving 26 Predictors for the so called "1st Thinning Algorithm"

Variable Removed	Wald Chi-Square	Pr > Chi-Square
GADT	0.0445	0.8329
OTHVEHO	0.8289	0.3626
GADS2	1.1198	0.2900
BAG	2.5557	0.1099

4

* = insignificant

Table III. Coefficients of "1st Thinning Algorithm", with and without Sampling Error; Basis for Further Thinning (Stars) in Arriving at the "Baseline Algorithm"

	No Sampling Error		With Sampling Error		
Coeffic.	V1	EV1	V2	EV2	PROB2
INTERCPT	-5.21340	0.032800	-5.2134	0.5217	0.0000
OTHVEH1	-0.41800	0.005630	-0.4180	0.1057	0.0001
* ROLL	0.20200	0.008350	0.2020	0.1342	0.1322
GADF	0.98060	0.007750	0.9806	0.1392	0.0000
GADS1	0.96900	0.008570	0.9690	0.1725	0.0000
EXT1	-2.44640	0.015100	-2.4461	0.2155	0.0000
EXT2	-1.30260	0.008150	-1.3026	0.1454	0.0000
EXT3	-0.85540	0.007060	-0.8554	0.1292	0.0000
* EXT4	-0.07740	0.008030	-0.0774	0.1780	0.6636
LOSSINT	0.83850	0.007310	0.8385	0.1525	0.0000
INTRU	0.75620	0.007180	0.7562	0.1386	0.0000
SEATDISR	0.46260	0.008750	0.4626	0.1416	0.0011
RIMDEF	0.59970	0.006520	0.5997	0.1120	0.0000
FIRE	1.04090	0.025700	1.0400	0.3260	0.0010
* CURBWT	-0.01120	0.000413	-0.0112	0.0075	0.1365
SEATF	0.41380	0.009380	0.4138	0.1504	0.0059
BELT	-0.79890	0.005480	-0.7989	0.0927	0.0000
BEBA	-0.88920	0.021100	-0.8892	0.2849	0.0018
AGE	0.03060	0.000134	0.0306	0.0025	0.0000
* GENDER	-0.01510	0.005700	-0.0151	0.0955	0.8741
* OCCWT	-0.00209	0.000088	-0.0021	0.0015	0.1676
* OCCHT	-0.00120	0.000562	-0.0012	0.0089	0.8927
* ABNPOST	-0.36640	0.012200	-0.3664	0.2538	0.1488
ENTRAP	1.87450	0.011000	1.8745	0.2476	0.0000
EJC	2.21840	0.009960	2.2184	0.1747	0.0000
EJP	1.99240	0.010000	1.9924	0.1709	0.0000
OTHRINJ	2.57660	0.008690	2.5766	0.1346	0.0000

Table IV. Coefficients of "1st Thinning Algorithm", Compared with those of the "Baseline Algorithm"

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	"1st Thinning Algorithm"			"Baseline Algorithm"		
Coeffic.	V2	EV2	PROB2	VV2	EVV2	PPROB2
INTERCPT	-5.2134	0.5217	0.0000	-5.7392	0.1287	0.0000
OTHVEH1	-0.4180	0.1057	0.0001	-0.4214	0.0944	0.0000
ROLL	0.2020	0.1342	0.1322			
GADF	0.9806	0.1392	0.0000	0.9189	0.1108	0.0000
GADS1	0.9690	0.1725	0.0000	0.9699	0.1244	0.0000
EXT1	-2.4461	0.2155	0.0000	-2.3488	0.1927	0.0000
EXT2	-1.3026	0.1454	0.0000	-1.1921	0.1220	0.0000
EXT3	-0.8554	0.1292	0.0000	-0.7716	0.0971	0.0000
EXT4	-0.0774	0.1780	0.6636			
LOSSINT	0.8385	0.1525	0.0000	0.6409	0.1262	0.0000
INTRU	0.7562	0.1386	0.0000	0.6213	0.1165	0.0000
SEATDISR	0.4626	0.1416	0.0011	0.6819	0.1228	0.0000
RIMDEF	0.5997	0.1120	0.0000	0.4422	0.1049	0.0000
FIRE	1.0400	0.3260	0.0010	1.4162	0.3466	0.0000
CURBWT	-0.0112	0.0075	0.1365			
SEATF	0.4138	0.1504	0.0059	0.4105	0.1137	0.0003
BELT	-0.7989	0.0927	0.0000	-0.8273	0.0737	0.0000
BEBA	-0.8892	0.2849	0.0018	-0.8658	0.2489	0.0005
AGE	0.0306	0.0025	0.0000	0.0272	0.0018	0.0000
GENDER	-0.0151	0.0955	0.8741			
OCCWT	-0.0021	0.0015	0.1676			
OCCHT	-0.0012	0.0089	0.8927			
ABNPOST	-0.3664	0.2538	0.1488			
ENTRAP	1.8745	0.2476	0.0000	2.4115	0.1806	0.0000
EJC	2.2184	0.1747	0.0000	2.7848	0.1089	0.0000
EJP	1.9924	0.1709	0.0000	2.1685	0.1365	0.0000
OTHRINJ	2.5766	0.1346	0.0000	2.5667	0.1161	0.0000

Table V. Relative Invariance of the "Baseline Algorithm", Irrespective of Shown Database

	Entire Database			One Half			Other Half		
Predictor	Coef	StdEr	Test	Coef	StdEr	Test	Coef	StdEr	Test
INTRCPT	-5.739	0.128	0.000	-5.701	0.164	0.000	-5.800	0.200	0.000
OTHVEH1	-0.421	0.094	0.000	-0.590	0.121	0.000	-0.257	0.139	0.064
GADF	0.918	0.110	0.000	1.011	0.146	0.000	0.809	0.165	0.000
GADS1	0.969	0.124	0.000	0.996	0.171	0.000	0.931	0.178	0.000
EXT1	-2.348	0.192	0.000	-2.244	0.245	0.000	-2.459	0.305	0.000
EXT2	-1.192	0.122	0.000	-1.229	0.176	0.000	-1.183	0.169	0.000
EXT3	-0.771	0.097	0.000	-0.721	0.144	0.000	-0.847	0.131	0.000
LOSSINT	0.640	0.126	0.000	0.299	0.166	0.072	0.984	0.179	0.000
INTRU	0.621	0.116	0.000	0.840	0.170	0.000	0.417	0.152	0.006
SEATDISR	0.681	0.122	0.000	0.742	0.184	0.000	0.614	0.160	0.000
RIMDEF	0.442	0.104	0.000	0.506	0.151	0.000	0.363	0.143	0.011
FIRE	1.416	0.346	0.000	1.067	0.319	0.000	1.600	0.490	0.001
SEATF	0.410	0.113	0.000	0.397	0.148	0.007	0.434	0.175	0.013
BELT	-0.827	0.073	0.000	-0.800	0.104	0.000	-0.856	0.103	0.000
BEBA	-0.865	0.248	0.000	-1.137	0.368	0.002	-0.637	0.335	0.057
AGE	0.027	0.001	0.000	0.027	0.002	0.000	0.027	0.002	0.000
ENTRAP	2.411	0.180	0.000	2.506	0.306	0.000	2.321	0.194	0.000
EJC	2.784	0.108	0.000	2.849	0.153	0.000	2.735	0.153	0.000
EJP	2.168	0.136	0.000	2.389	0.186	0.000	1.930	0.197	0.000
OTHRINJ	2.566	0.116	0.000	2.530	0.172	0.000	2.624	0.157	0.000

Table VI. Derivation of "Lean Algorithm" from "Baseline Algorithm" via Shown Transactions;

x Elimination
* Consolidation
= Result of Consolidation

		"Baseline Algorithm"			"Lean Algorithm"		
	Predictor	Coef	StdEr	Test	Coef	StdEr	Test
	INTRCPT	-5.739	0.128	0.000	-5.3171	0.0836	0.0000
x	OTHVEH1	-0.421	0.094	0.000			
	GADF	0.918	0.110	0.000	1.1045	0.0932	0.0000
	GADS1	0.969	0.124	0.000	0.8354	0.1079	0.0000
	EXT1	-2.348	0.192	0.000	-2.6789	0.1864	0.0000
	EXT2	-1.192	0.122	0.000	-1.4631	0.1150	0.0000
	EXT3	-0.771	0.097	0.000	-0.9571	0.0934	0.0000
	LOSSINT	0.640	0.126	0.000	0.8293	0.1220	0.0000
	INTRU	0.621	0.116	0.000	0.8425	0.1143	0.0000
x	SEATDISR	0.681	0.122	0.000			
x	RIMDEF	0.442	0.104	0.000			
x	FIRE	1.416	0.346	0.000			
x	SEATF	0.410	0.113	0.000			
*	BELT	-0.827	0.073	0.000			
*	BEBA	-0.865	0.248	0.000			
=	RESTR				-0.9435	0.0707	0.0000
	AGE	0.027	0.001	0.000	0.0275	0.0016	0.0000
*	ENTRAP	2.411	0.180	0.000			
*	EJC	2.784	0.108	0.000			
*	EJP	2.168	0.136	0.000			
=	GRU				2.6281	0.0830	0.0000
x	OTHRINJ	2.566	0.116	0.000			

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Table VII. The "Lean Algorithm" as Derived from Shown Databases

Coef.	Entire Database			One Half			The Other Half		
INTRCPT	-5.317	0.083	0.00	-5.305	0.118	0.000	-5.338	0.117	0.000
GADF	1.104	0.093	0.00	1.182	0.129	0.000	1.006	0.134	0.000
GADS1	0.835	0.107	0.00	0.826	0.152	0.000	0.834	0.152	0.000
EXT1	-2.678	0.186	0.00	-2.615	0.239	0.000	-2.750	0.292	0.000
EXT2	-1.463	0.115	0.00	-1.507	0.160	0.000	-1.439	0.163	0.000
EXT3	-0.957	0.093	0.00	-0.907	0.138	0.000	-1.028	0.127	0.000
LOSSINT	0.829	0.122	0.00	0.481	0.160	0.003	1.177	0.175	0.000
INTRU	0.842	0.114	0.00	1.067	0.163	0.000	0.628	0.153	0.000
RES	-0.943	0.070	0.00	-0.925	0.100	0.000	-0.963	0.098	0.000
AGE	0.027	0.001	0.00	0.027	0.002	0.000	0.027	0.002	0.000
GRU	2.628	0.083	0.00	2.762	0.124	0.000	2.502	0.110	0.000

Table VIII. Relative Strength of Predictors in the "Lean Algorithm"

Predictor	Odds Ratio	Lower 95% Bound	Upper 95% Bound
GADF	3.0177	2.5878	3.5190
GADS1	2.3057	1.9300	2.7547
EXT1	0.0686	0.0505	0.0933
EXT2	0.2315	0.1915	0.2799
EXT3	0.3840	0.3292	0.4479
LOSSINT	2.2917	1.8743	2.8020
INTRU	2.3221	1.9233	2.8036
RES	0.3892	0.3464	0.4374
AGE	1.0279	1.0251	1.0307
GRU	13.8473	12.0768	15.8774

Fig. 1. Evaluation of the Predictive Merits of the Baseline Algorithm for the Projection of Compelling Injury

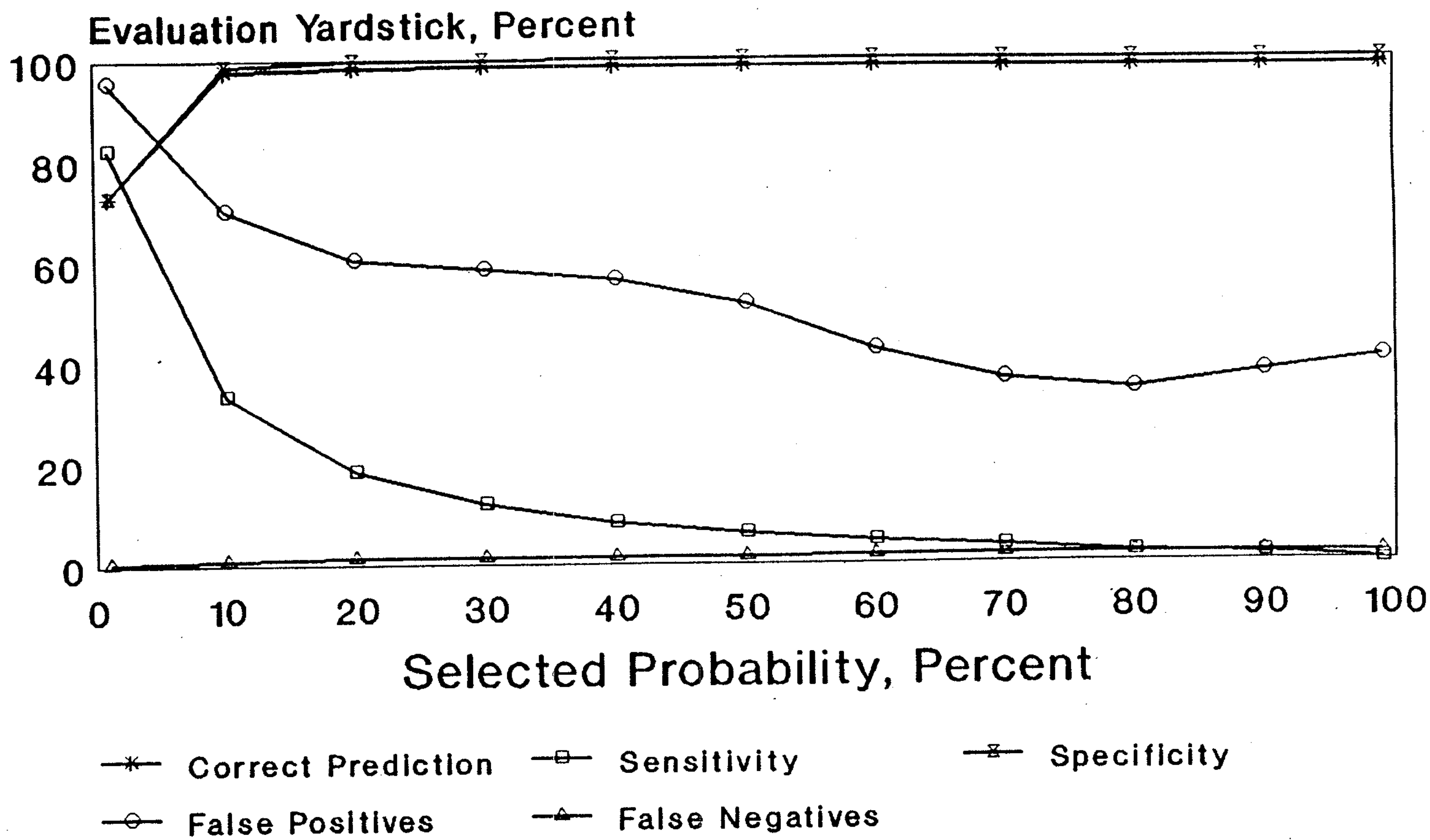

Fig. 2. Evaluation of the Predictive Merits of the Baseline Test Algorithm for Compelling Injury Projection

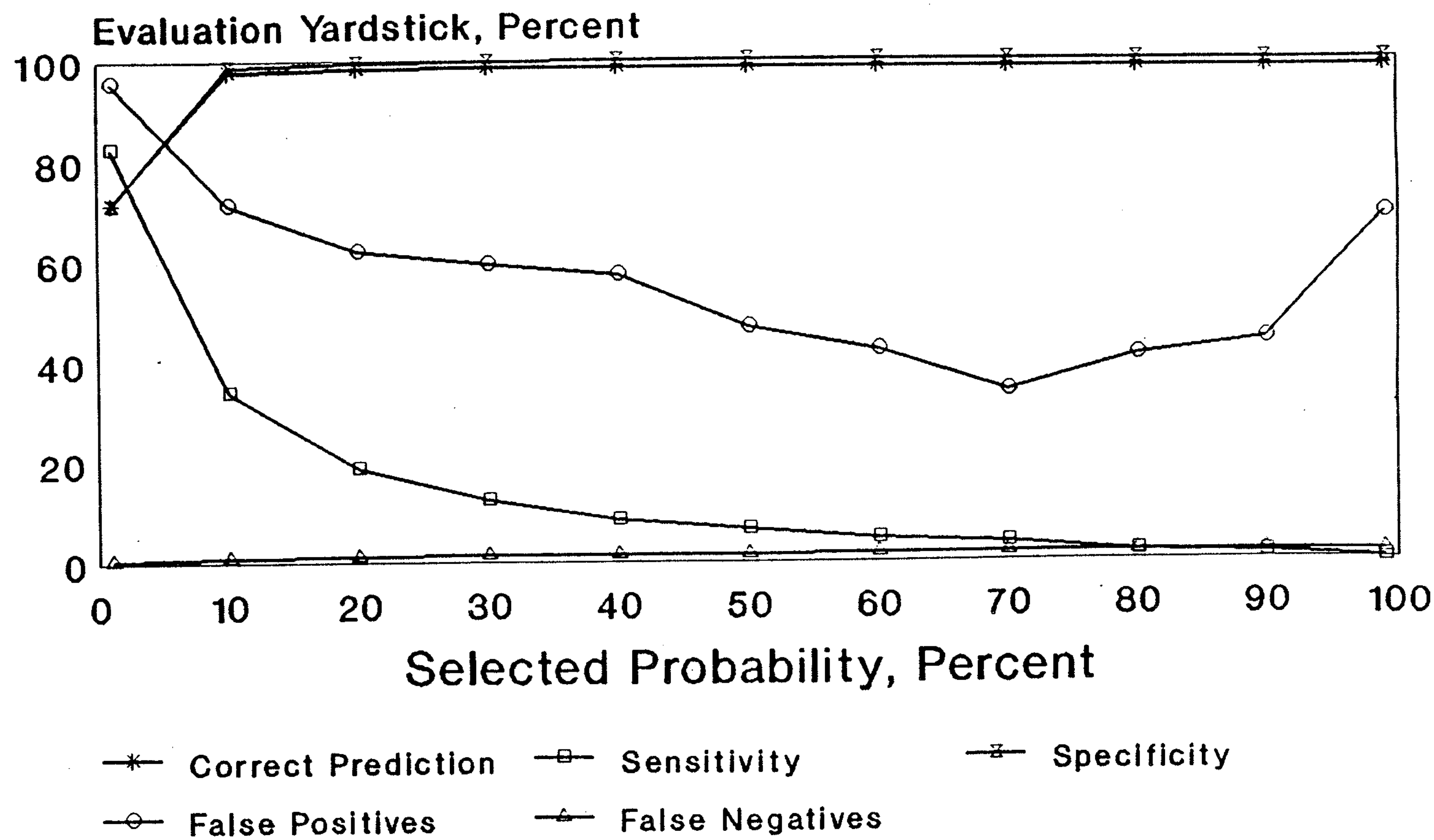

Fig. 3. Sensitivity of Shown Algorithms for the Projection of Compelling Injury

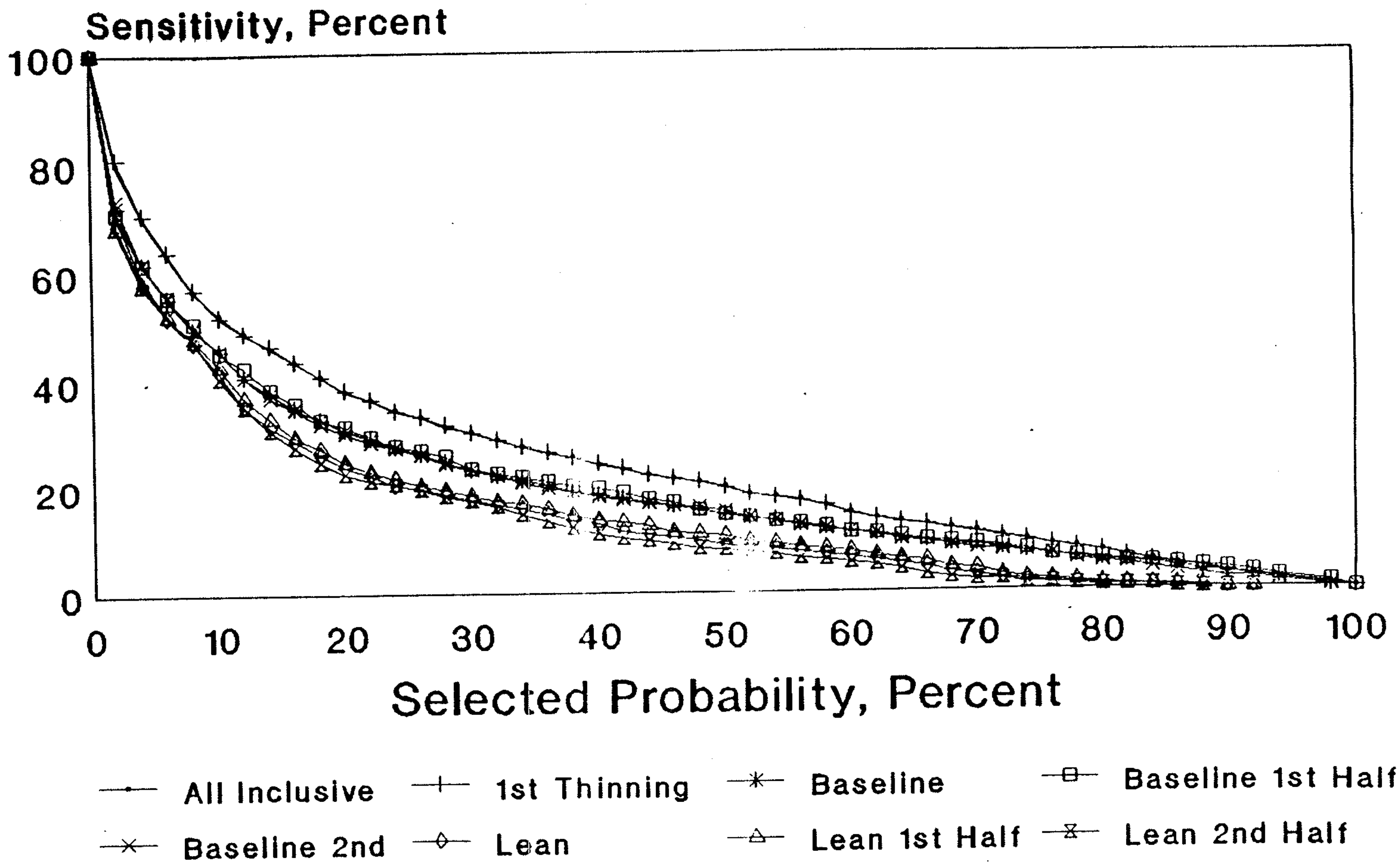

Fig. 4. Rate of False Positives in the Projection of Compelling Injury by Shown Algorithms

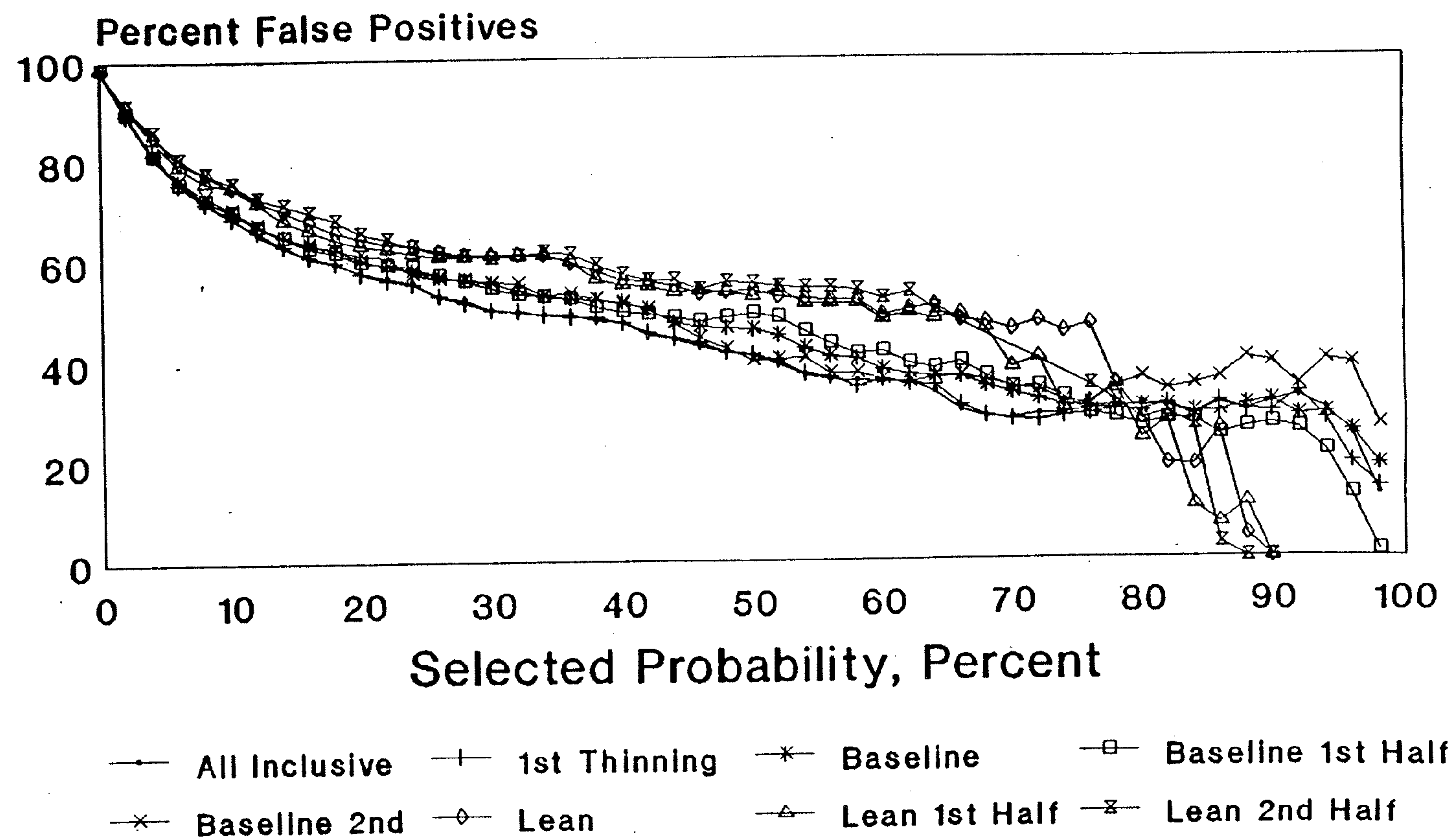

Fig. 5. Comparison of Sensitivity of Algorithms in the Projection of Compelling Injuries

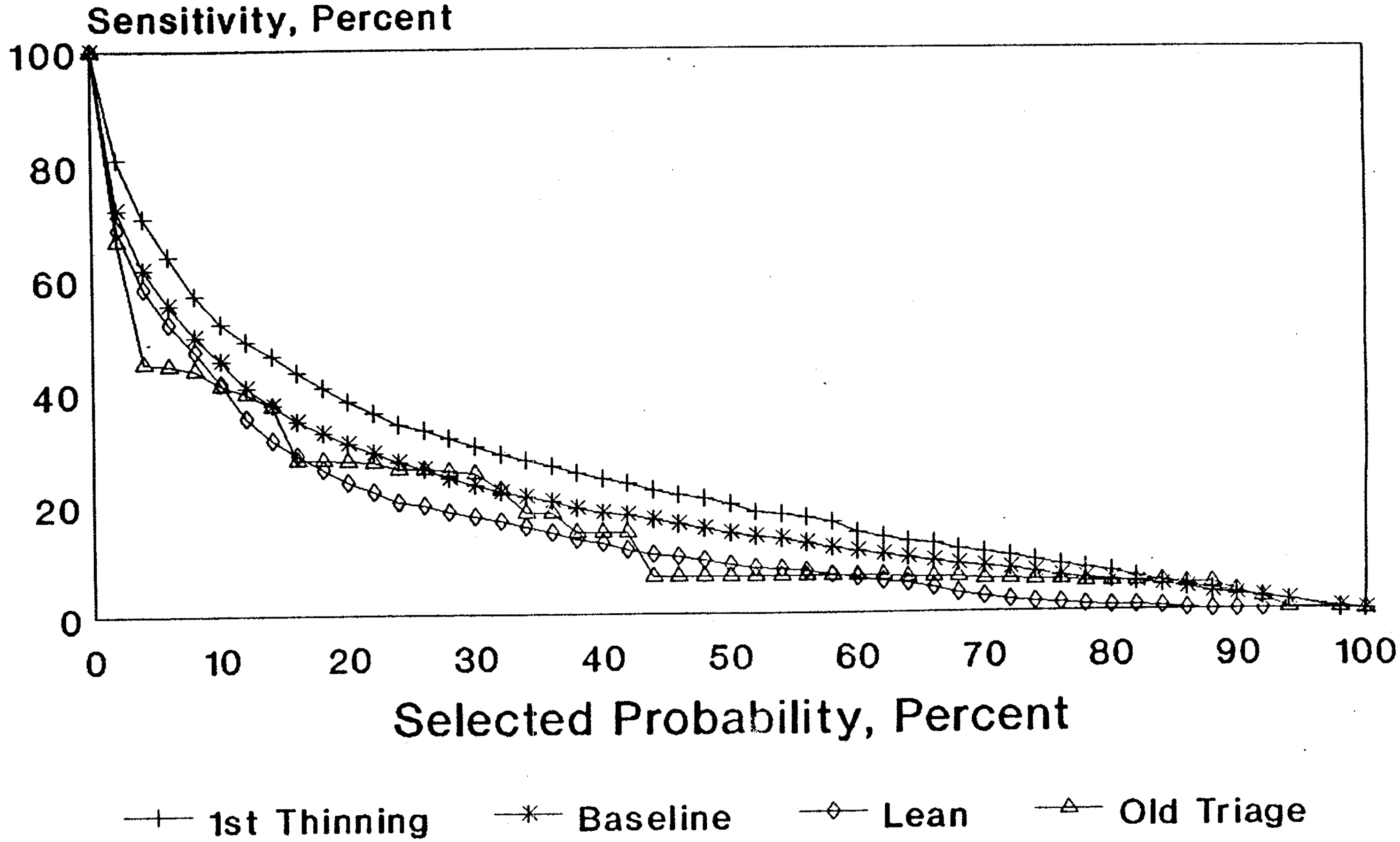

Fig. 6. Comparison of Rate of False Positives in the Projection of Compelling Injury by Shown Algorithms