

Supplemental Data Table S2. Overview of individual studies

Ref	Interventions	Tests studied							Clin outcome	Adherence	Sustainability	Reproducibility
		All	Chem	Hem	Coag	Urine	TM	Endo				
Education												
8	Presentations, discussions, flyers, email communication		X	X	X				Y	N	N	N
28	Team discussion during rounds		X						Y	N	N	Y
30	Implementation of a guideline		X						Y	N	N	Y
32	Range of educational efforts		X	X	X			X	Y	N	N	N
33	Implementation of standard operating protocols							X	N	N	N	N
18	Implementation of algorithm		X						Y	N	N	N
34	Implementation of guidelines		X						Y	N	N	N
35	Sessions on predictive value vs sessions on economic issues and cost control							X	Y	Y	N	N
36	Implementation of guideline and review of medical records vs no intervention		X	X					N	N	N	N
C)POE												
Soft stop interventions												
39	Pop-up upon ordering second ionized test within 72 hours after normal test		X						Y	Y	Y	Y
41	Pop-up upon repeat order within specific time interval vs no intervention		X						Y	Y	N	Y
43	Pop-up upon ordering of potentially inappropriate test		X			X			N	Y	N	Y
45	Pop-up upon ordering if previous result within same hospital stay		X						N	Y	Y	Y
46	Pop-up if most recent result is less than 90 days old						X		Y	Y	N	Y
47	Pop-up upon potentially redundant ordering of test						X		N	Y	Y	Y
49	Pop-up upon ordering within time specific interval vs determination of redundancy and suppression of pop-up		X		X			X	Y	Y	N	N
Hard stop interventions												
19	Rejection if not ordered according to order frequency rule							X	Y	Y	Y	Y
16	Rejection if ordering within minimum retesting interval or if not meeting rules		X					X	Y	Y	N	Y
53	Pop-up upon ordering same-day duplicate test, rejection of unnecessary order		X						Y	Y	Y	Y
55	Rejection of order if previous result within 48 hours vs no intervention		X						N	Y	N	Y
57	Rejection of order if requested within certain time interval after previous test		X			X	X	X	N	Y	Y	Y
Hard stop vs soft stop interventions												
60	Blocking of tests deemed unnecessary more than once per day vs pop-up upon ordering of tests deemed unnecessary more than once per day		X						N	Y	N	Y

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Supplemental Data Table S2. Continued

Ref	Interventions	Tests studied							Clin outcome	Adherence	Sustainability	Reproducibility
		All	Chem	Hem	Coag	Urine	TM	Endo				
	Order form changes, display of fee											
62	Redesign of order form through re-categorization of target test		X						N	Y	N	Y
64	Revision of test panels, reducing the number from 171 to 60	X							N	Y	N	Y
66	Display of charge and turn-around-time upon ordering test vs no intervention						X		N	Y	N	Y
67	Limiting range of laboratory tests allowed to order by changing paper request form	X							N	Y	N	Y
69	Display of charge upon ordering vs no intervention		X	X	X	X	X	X	N	Y	N	Y
20	Redesign of order form: removing tickbox for target test, requiring written request						X		Y	Y	N	Y
71	Change in order form indicating appropriateness (overruling of recommendation by providing reason on sheet) and display of charge of tumor marker requests on order form						X		N	Y	Y	N
73	Display of charge on order form		X	X	X	X			Y	Y	N	Y
74	Redesign of order form displaying only boxes for clinical conditions instead of individual tests vs no intervention						X		N	N	Y	N
76	Unbundling and translocation of test panels, grouping tests, implementation of algorithms		X	X	X	X	X	X	N	Y	N	N
77	Elimination of predefined multitest panels		X						N	Y	N	N
79	Computerized display of charge upon ordering vs no intervention	X							Y	N	N	Y
80	Change in order form indicating appropriateness of request						X		N	Y	N	Y
	Time limits on orders											
81	Elimination of ability to order daily recurrent tests		X	X	X	X			Y	Y	N	Y
83	Expiration of any laboratory order at 24 hours		X						N	Y	N	Y
85	Elimination of standing orders for laboratory studies		X						Y	N	N	N
	Combined (C)POE & Others											
7	Time-limit on ordering, daily order set for appraisal of tests ordered daily, patient summary tab to permit rapid review of active orders		X	X	X	X			Y	Y	N	Y
88	Implementation of inpatient electronic health record with CPOE	X							Y	Y	N	N
90	Order form change through listing organs/diagnoses which directed to the test that could be requested, changing regulations for requests						X		N	Y	N	Y
92	Time-limit on ordering, display of previous test result upon ordering, display of testing guidelines		X						N	Y	Y	Y

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Supplemental Data Table S2. Continued

Ref	Interventions	Tests studied							Clin outcome	Adherence	Sustainability	Reproducibility	
		All	Chem	Hem	Coag	Urine	TM	Endo					Other
Others													
27	Review of microbiology send-out test requests								X	N	Y	N	Y
29	Review of reference test requests before approval								X	N	Y	N	Y
31	Review of reference test requests								X	N	Y	N	Y
15	Change of providers allowed to order tests, ordering individualized instead of through surgery-specific pathway	X								Y	Y	N	Y
Education & Audit/Feedback													
25	Information on charges, weekly feedback on mean volume and charges	X								N	N	N	Y
24	Presentations and flyers on high value care principles, pocket cards with charges, weekly feedback with peer comparison vs no intervention		X	X						Y	N	N	Y
3	Educational seminars on overutilization, weekly feedback reports on ordering habits		X	X	X				X	N	N	N	N
37	Implementation of guidelines, audit and feedback method not further specified		X							Y	N	N	N
10	Implementation of guidelines, lectures on use of laboratory tests, reminder letters, feedback on test use vs no intervention		X						X	N	N	Y	N
38	Emails with recommendations on laboratory ordering, monthly feedback		X	X						Y	N	N	N
40	Education regarding indications for target test ordering, physicians informed of results of previous audit on ordering behavior		X							N	N	N	N
42	Discussions of related literature, feedback on previous 3 years, feedback on first months after intervention		X							N	N	N	N
44	Guide with ordering rules and test costs, educational sessions, monthly feedback		X	X						Y	N	N	N
9	Implementation of ordering guidelines, monthly update on outcome	X								Y	Y	N	Y
11	Feedback on previous audit of appropriateness of testing, review of literature, discussion on strategies for reducing unnecessary testing		X	X						Y	Y	N	Y
48	Educational information, feedback on blood loss from phlebotomy	X								N	N	N	N
50	Implementation of guidelines, teaching sessions, monthly feedback on adherence and impact of guidelines vs no intervention		X							Y	Y	N	N
51	Teaching rounds, weekly review of cost data		X							Y	N	N	N
52	Discussing cost issues and unnecessary testing, feedback on ordering patterns relative to peers, implementation of guidelines		X	X	X	X	X	X		Y	N	N	Y

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Supplemental Data Table S2. Continued

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		All	Chem	Hem	Coag	Urine	TM	Endo					Other
Education & (C)POE													
54	Revision of protocols, lectures, omission of tests from standard panels, implementation of presets	X								N	Y	N	N
56	Alert upon ordering in specific patients, education through email							X		N	N	N	N
58	Implementation of guidelines, incorporation into admission templates on CPOE screen, educational sessions vs no intervention	X	X							Y	N	N	Y
59	Information campaign, clinical justification needed if more parameters ordered, implementation of algorithm							X		N	N	N	N
Education & Others													
61	Staff education, visual reminders, daily checklists	X	X	X						Y	N	N	N
63	Daily information for staff, reminders at bedside of test information and costs, incentive	X	X	X	X					Y	N	N	N
65	One day email discussions about utility and costs of CRP testing, no CRP day with gold coin penance if ordered	X								N	N	N	N
Audit/Feedback & (C)POE													
68	Implementation of computerized protocol management system, monthly summary of investigations used as basis for regular discussions	X								Y	Y	N	Y
(C)POE & Other													
70	Checklist enabling physicians to assess necessity for testing daily, restriction on scheduling tests to 24-hour interval	X	X	X	X					Y	N	N	N
72	Co-payment fee for nonemergent visits, reducing the number of eligible tests to order from the Emergency Department	X								N	Y	N	N
Education, (C)POE & Other													
75	Educational sessions, item on ICU checklist regarding routine blood tests, prompt in order system that compelled provider to specify indication for test	X	X							Y	N	N	Y
21	Implementation of guidelines, removal of tests from order set, pop-up warning upon ordering not according to specific rules, change of providers allowed to order tests	X								Y	N	N	Y
78	Implementation of protocol, rejection if request within 24 hours of previous request, consultant only requesting vs no intervention	X								N	N	N	N
22	Unbundling of panels, series of lectures on economic implications of excessive use of testing, supervision of ordering by senior physician vs no intervention	X								Y	N	Y	N

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Supplemental Data Table S2. Continued

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		All	Chem	Hem	Coag	Urine	TM	Endo				
Education, Audit/Feedback & Other												
14	30-minute discussion, pocket cards with charges, discussion of laboratory tests within rounds, incentive, monthly feedback of average and individual performance vs no intervention	X	X	X	X				Y	N	N	N
82	Implementation of guidelines, discouragement of use of panel, monthly feedback on ordering volume, financial incentive	X							Y	N	N	Y
84	Daily discussion of need for testing, daily coaching of resident, regular feedback on volume and costs, approval of superior needed for ordering daily tests	X						N	N	N	Y	N
86	One hour discussion, incentive, periodic feedback on performance in relation to testing goals vs one hour discussion, chart review sessions vs one hour discussion	X					X	Y	N	N	N	N
Education, Audit/Feedback & (C)POE												
87	Monthly discussions and feedback, unbundling panel	X						N	N	N	N	N
89	Educational sessions, feedback on results of previous audit, implementation of algorithm, replacement of four-component panel with two-component panel on order form				X			Y	N	N	Y	N
91	Restricting available emergency laboratory tests and allowed frequency of repeated orders, presentation on misuse of tests and restrictive strategy, feedback of results vs no intervention	X						Y	N	N	N	Y
Education, Audit/Feedback, (C)POE & Other												
93	Educational sessions and newsletters, quarterly feedback, elimination of standing daily orders, incentive	X	X	X	X			Y	N	N	Y	Y
94	Implementation of guidelines, educational campaign, feedback on individual provider level, removal of tests from quick-pick screen, pop-ups upon ordering specific tests, justification needed for requesting daily tests beyond 3 days, use of admission templates, discontinuing tests of limited usefulness	X						N	N	N	Y	N

Abbreviations: Clin, clinical; Ref, reference; Chem, chemistry; Hem, hematology; Coag, coagulation; TM, tumor markers; Endo, endocrinology; Y, yes; N, no.