Performance evaluation of the cobas® t 711 coagulation analyzer

WHITE PAPER

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1. Executive summary

The **cobas** t 711 coagulation analyzer utilizes a walk-away reagent management (W.A.R.M.) concept and has demonstrated accurate and reproducible sample measurement in routine practice. We explored how the W.A.R.M. concept can streamline workflow and efficiency in the real-world coagulation laboratory environment. A fixed protocol of tests was conducted on anonymized residual patient samples using the **cobas** t 711 coagulation analyzer alongside three comparator systems. Extended routine testing was faster on the **cobas** t 711 coagulation analyzer than on the comparator systems. Total and weekly hands-on time was negligible on the **cobas** t 711 coagulation analyzer; when all stages of the laboratory workflow are considered, overall time was shorter on the **cobas** t 711 coagulation analyzer compared with comparator systems. Several factors associated with the W.A.R.M. concept were found to reduce the laboratory workload and increase efficiency. These included the high test capacity, good onboard stability, reduced reagent top-ups, automated reconstitution, and automated overnight maintenance. The reduction in human intervention required at each step may also result in a lower chance of introduced errors. All outcomes relating to quality control were slower with the **cobas** t 711 coagulation analyzer versus comparator analyzers. However, automated maintenance processes that require no hands-on time from laboratory staff can happen in the background and can be programmed to take place at night. In summary, automation, reduced hands-on time, and walk-away capabilities are important assets in the contemporary laboratory environment, and these results indicate that the **cobas** t 711 coagulation analyzer could streamline workflow and efficiency in coagulation laboratories.

2. Introduction

Coagulation tests are widely used in clinical practice for the screening, diagnosis, and assessment of coagulopathies, in addition to the therapeutic drug monitoring of anticoagulant therapies.[1-6] Therefore, the availability of reliable automated laboratory tests that can quickly provide accurate and precise results is essential.[7-10]

The development of new-generation, fully automated, high-throughput coagulation analyzers aims to address this clinical need and increase the precision of results reporting.[8] In addition, there is a current widespread shortage of skilled laboratory professionals.[11-13] Thus, high-throughput analyzers with reduced hands-on time and expanded capabilities are now indispensable for adequate laboratory coverage and optimized workforce productivity.

The connectable or standalone high-throughput **cobas** t 711 coagulation analyzer (Roche Diagnostics International Ltd, Rotkreuz, Switzerland; **Figure 1**) is a new-generation, fully automated coagulation analyzer that utilizes reagent cassettes offering automatic reconstitution of lyophilized reagents.[14] These reagent cassettes are designed to maximize automation and programmability, enabling the introduction of the walk-away reagent management (W.A.R.M.) concept.

There are several differences between a traditional laboratory setting, which requires hands-on time from laboratory personnel, and the W.A.R.M. concept, as offered by the **cobas** t 711 coagulation analyzer (**Figure 2**).

Amongst the differences, the large onboard reagent capacity and a minimum of 2 weeks of onboard stability for unopened cassettes reduces the need to regularly retrieve reagents from a separate area.[15] In addition, loading and unloading of reagents, samples, and consumables on the **cobas** t 711 coagulation analyzer can happen at any time without interrupting the testing.[15]

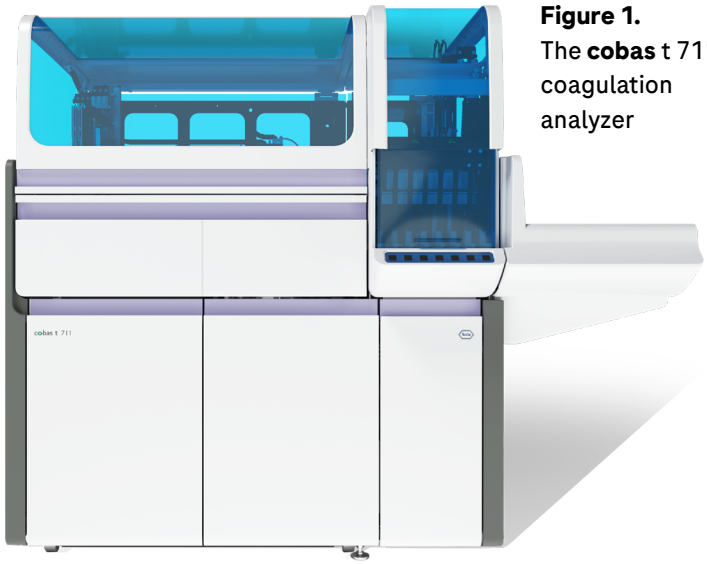


Figure 1.
The **cobas** t 711 coagulation analyzer

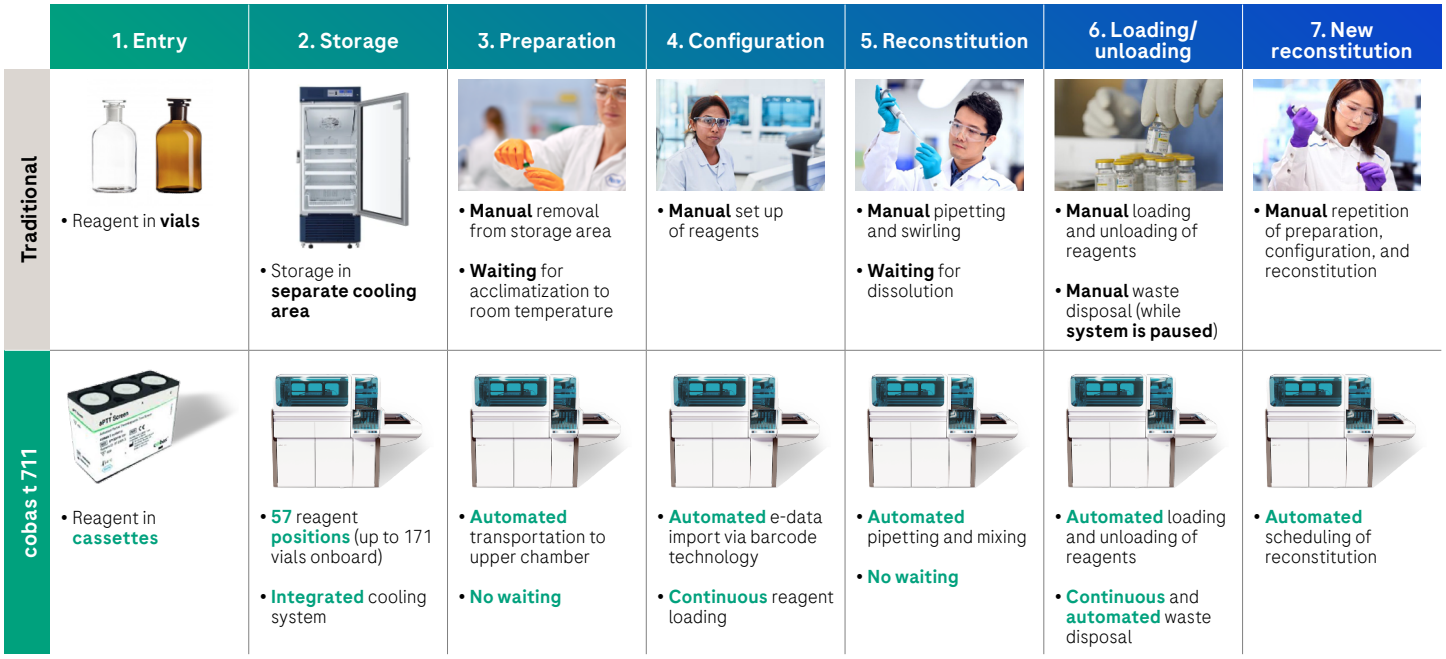


Figure 2. Traditional laboratory setting versus the walk-away reagent management (W.A.R.M.) concept with the **cobas** t 711 coagulation analyzer

The **cobas** t 711 coagulation analyzer is not available in the US.

3. An evaluation of the cobas® t 711 coagulation analyzer

The high-throughput **cobas** t 711 coagulation analyzer has previously been shown to be suitable for the accurate and reliable measurement of coagulation parameters in routine clinical practice.[8 14] We explored how the W.A.R.M. concept can streamline workflow and efficiency in coagulation laboratories by collecting both quantitative and qualitative data for laboratory processes observed in real-world environments on the **cobas** t 711 coagulation analyzer, alongside three comparator systems.

Methods

Studies were conducted in 2018 at three laboratories in Germany (Augsburg, Berlin, and Hamburg), with 5 days of direct observation at each site. Each of the three laboratories used the **cobas** t 711 coagulation analyzer and one different comparator analyzer: the Augsburg laboratory used a Sysmex® CS-5100 Hemostasis System (Siemens Healthineers), the Berlin laboratory used a STA R Max® (Diagnositica Stago), and the Hamburg laboratory used an ACL TOP 700 (Werfen).

Test protocols

A fixed protocol of tests was employed at each site, consisting of four testing runs of 30 specimens each. Each specimen underwent the following: basic routine testing (prothrombin time [PT], activated partial thromboplastin time [aPTT], fibrinogen); extended routine testing (PT, aPTT, fibrinogen, antithrombin [AT], D-dimer, thrombin time [TT]); anticoagulation monitoring (anti-factor Xa [Anti-Xa]); and thrombosis investigation (D-dimer).

Outcomes

Outcomes included the total testing automation time for basic routine testing, extended routine testing, anticoagulation monitoring, and thrombosis investigation. Reagent handling data were divided into:

1. Hands-on time for reagent preparation, reagent reconstitution, and loading the reagents onto the instrument, including brief periods of waiting;
2. Test capacity (approximate maximum number of tests which can be performed with a single vial or cassette) and onboard stability (stability of reagent after it has been loaded onto the instrument and reconstituted/opened);
3. Total weekly (direct hands-on time only) and monthly hands-on time (including automation and waiting times) for reagent handling, cycle time per month (total time to complete the process, including automation and waiting from the technician's perspective), and total hands-on time for completion of 500 tests (using liquid and lyophilized reagents) were also calculated.

Quality control time was divided into: hands-on time (time needed to perform tasks requiring direct physical interaction), waiting time (waiting during reconstitution or thawing of control materials), and testing automation (time elapsed between placing the order for controls and receiving the results). Daily, weekly, and monthly maintenance time was divided into hands-on time (manual work only) and cycle time (total time, including automation and waiting). One set of data per comparator system was obtained versus the three data sets obtained with the **cobas** t 711 coagulation analyzer; measurements for the **cobas** t 711 coagulation analyzer were pooled across the three sites.

Results

The results for the individual outcomes pertaining to testing time, reagent handling, quality control, and maintenance specifically for the **cobas**® t 711 coagulation analyzer can be seen in **Table 1**.

The mean values for the **cobas** t 711 coagulation analyzer can also be reviewed alongside those of the comparator systems (**Table 2**). Turnaround times for routine assays were comparable for all systems. Total testing automation time for extended routine testing was comparable between the **cobas** t 711 coagulation analyzer and Sysmex CS-5100, and faster with the **cobas** t 711 coagulation analyzer versus the two other comparator analyzers.

Table 1. Performance of the **cobas** t 711 coagulation analyzer: testing time, reagent handling, quality control, and maintenance

Test site	Augsburg	Berlin	Hamburg	Mean values
Testing time (total test automation)				
Basic routine testing time [min]	35.45	35.47	36.9	**35.9**
Extended routine testing time [min]	65.30	59.58	61.04	**62.0**
Automation time for anticoagulation monitoring (Anti-Xa) [min]	24.03	23.70	23.82	**23.9**
Automation time for thrombosis investigation (D-dimer) [min]	30.22	30.43	32.20	**31.0**
Reagent handling				
Weekly total hands-on time for reagent handling [min]	1.7	2.0	1.9	**1.87**
Weekly total hands-on time for loading the reagents [min]	5.1	5.5	3.6	**4.73**
Weekly total hands-on time for reagent reconstitution [min]	1.7	1.7	1.7	**1.70**
Hands-on time needed to process 500 tests for liquid reagents (no reconstitution required) [min]	1.4	1.5	1.1	**1.33**
Hands-on time needed to process 500 tests for lyophilized reagents (reconstitution required) [min]	2.5	2.6	2.1	**2.40**
Cycle time per month, including automation and waiting time [h]	0.65	0.7	0.49	**0.613**
Quality control				
Hands-on time for quality control preparation [min]	17.4	15.5	11.9	**14.9**
Waiting time for reconstitution of controls [min]	30	30	30	**30.0**
Testing automation time (time needed by the analyzer to perform the controls) [min]	17.6	19.4	36.1	**24.4**
Total time taken for quality control procedures [min]	72.1	64.9	78	**71.7**
Maintenance				
Daily hands-on time [min]	0.4	0.3	0.4	**0.367**
Daily cycle time [min]	12.6	12.7	n/a	**12.7**
Weekly hands-on time [min]	43	25.6	27.5	**32.0**
Weekly cycle time [min]	78.2	58.9	49	**62.0**
Monthly hands-on time [h]	1.9	3.8	3.8	**3.17**
Monthly cycle time [h]	1.9	3.8	3.75	**3.15**

Site-specific data are reported to the level of accuracy provided. Means are presented with three significant digits
Anti-Xa=anti-factor Xa, n/a=not available

Testing automation time for both D-dimer and Anti-Xa was longer with the **cobas**® t 711 coagulation analyzer compared with the other systems. All outcomes relating to reagent handling were faster with the **cobas** t 711 coagulation analyzer versus comparator analyzers. When automation and waiting time were included, the **cobas** t 711 coagulation analyzer required 97% less cycle time per month than the comparator analyzers (0.61 h versus a mean of 20.7 h across the three comparators).

Table 2. Mean performance of the **cobas** t 711 coagulation analyzer versus comparator systems

Test site	Augsburg Siemens Sysmex CS-5100	Berlin STA R Max	Hamburg ACL TOP 700	Mean comparator values[A]	Mean values cobas t 711
Testing time (total test automation)					
Basic routine testing time [min]	33.65	33.65	37.15	34.8	↑35.9
Extended routine testing time [min]	63.46	82.58	72.18	72.7	↓62.0
Automation time for anticoagulation monitoring (Anti-Xa) [min]	17.57	19.24	14.73	17.2	↑23.9
Automation time for thrombosis investigation (D-dimer) [min]	17.81	20.99	16.45	18.4	↑31.0
Reagent handling					
Weekly total hands-on time for reagent handling [min]	41.2	70.7	14.7	42.2	↓1.87
Weekly total hands-on time for loading the reagents [min]	20.6	62.6	22.8	35.3	↓4.73
Weekly total hands-on time for reagent reconstitution [min]	45.6	35.8	3.4	28.3	↓1.70
Hands-on time needed to process 500 tests for liquid reagents (no reconstitution required) [min]	27.9	36.8	25.5	30.1	↓1.33
Hands-on time needed to process 500 tests for lyophilized reagents (reconstitution required) [min]	29	32.8	7.1	23.0	↓2.40
Cycle time per month, including automation and waiting time [h]	19.12	24.95	18.14	20.7	↓0.613
Quality control					
Hands-on time for quality control preparation [min]	8.9	5.8	4.4	6.37	↑14.9
Waiting time for reconstitution of controls [min]	30	30	26.1	28.7	↑30.0
Testing automation time (time needed by the analyzer to perform the controls) [min]	31.7	22.7	10.2	21.5	↑24.4
Total time taken for quality control procedures [min]	70.6	51.2	46.9	56.2	↑71.7
Maintenance					
Daily hands-on time [min]	1.4	6	5.8	4.40	↓0.367
Daily cycle time [min]	1.4	6	11.9	6.43	↑12.7
Weekly hands-on time [min]	12.3	49.9	19.5	27.2	↑32.0
Weekly cycle time [min]	16.5	49.9	19.5	28.6	↑62.0
Monthly hands-on time [h][B]	15	-	4	9.50	↓3.17
Monthly cycle time [h][B]	15	-	124	69.5	↓3.15

Site-specific data are reported to the level of accuracy provided. Means are presented with three significant digits
↓ Lower than the comparator mean; ↑ Higher than the comparator mean
[A]Mean value taken across the three different comparator systems
[B]Monthly maintenance not performed on the Stago STA R Max; analyzer excluded from monthly maintenance calculations
Anti-Xa=anti-factor Xa

All outcomes relating to quality control were slower with the **cobas**® t 711 coagulation analyzer versus comparator analyzers. From a maintenance perspective, hands-on time related to daily maintenance of the **cobas** t 711 coagulation analyzer was negligible, and shorter than for all the comparator analyzers. The weekly maintenance hands-on time was longer for the **cobas** t 711 coagulation analyzer compared with Sysmex CS-5100 and ACL TOP 700, but shorter than the STA R Max. Both daily and weekly cycle times were longer for the **cobas** t 711 coagulation analyzer versus the comparator analyzers. Monthly maintenance hands-on time and cycle time were shorter for the **cobas** t 711 coagulation analyzer versus the comparator analyzers.

When combining reagent handling, quality control, and maintenance, the monthly workload was substantially reduced using the **cobas** t 711 coagulation analyzer W.A.R.M. concept versus the comparator analyzers, taking 37% less time than the mean time taken by comparator analyzers (42.8 h versus 68.7 h).

Automation, hands-on time, and walk-away capabilities are important points in the contemporary laboratory environment. The data from this study provide robust and practical information around the potential impact of the **cobas** t 711 coagulation analyzer on workflow and staff efficiency. Previous analyses have demonstrated that the high reagent loading capacity of the **cobas** t 711 coagulation analyzer requires less frequent reagent top-ups which, coupled with the automatic reagent reconstitution, can reduce technician daily workload and increase laboratory efficiency.[14] The W.A.R.M. concept is also associated with minimal hands-on time for both liquid and lyophilized reagents, whereas the traditional laboratory approach may require more time for manual reagent handling.

The values for test capacity and onboard stability observed with the **cobas** t 711 coagulation analyzer indicate the number of times that new reagent cassettes need to be loaded (**Table 3**). This is influenced by the refrigerated storage compartment in the **cobas** t 711 coagulation analyzer and the design of the cassettes, which contain three separate vials that are sealed and only opened when needed. Moreover, the test cassettes for the **cobas** t 711 coagulation analyzer are pierced with a needle during the assay process, reducing the interaction with the external environment to minimize the risk of contamination and evaporation. In contrast, open vials are required in all other analyzers, leading to an increased evaporation of the contents.

Table 3. Mean test capacity and onboard stability of the **cobas** t 711 coagulation analyzer versus comparator systems

Testing site	Augsburg Siemens Sysmex CS-5100	Berlin STA R Max	Hamburg ACL TOP 700	Mean comparator values[A]	cobas t 711 values
Test capacities of vials/cassettes, n					
	Vials	Vials	Vials	Vials	Cassettes
Anti-Xa	34	152[B]	25	70.3	↑100
aPTT	200	88	130	139	↑600
AT	50	51	30	43.7	↑100
D-dimer	34	44[C]	40	39.3	↑100
Fibrinogen	70	41[D]	130	80.3	↑210
PT	118	88	130	112	↑354[E]
TT[F]	50	70	-	60.0	↑150
Onboard stability of reagent, days					
Anti-Xa[16]	3	3	3	3.00	↑7.00[G]
aPTT[17]	2	1	5	2.67	↑5.00
AT[18]	7	7	7	7.00	↑28.0
D-dimer[19]	2	15	7	8.00	↑28.0[H]
Fibrinogen[20]	1	3[C]	2	2.00	↑5.00
PT[21]	7	2	10	6.33	↓5.00[I]
TT[22, F]	7	7	-	7.00	↓5.00

↓ Lower than the comparator mean; ↑ Higher than the comparator mean

[A]Mean value taken across the three different comparator systems; [B]Value based on STA®-Liquid Anti-Xa reagent 1; [C] Value based on STA®-Liquid D-dimer reagent 1; [D]Value based on STA®-Liquid Fibrinogen reagent 1; [E]Value based on **cobas** PT reagent 1; [F]TT conducted at Augsburg and Berlin sites only; [G]Onboard stability adjusted to 14 days after reagent cassette piercing, per package insert (2022);[23] [H]Onboard stability adjusted to 84 days after reagent cassette piercing, per package insert (2022);[24] [I]Onboard stability adjusted to 10 days after reagent vial reconstitution, per package insert (2022)[25]

Anti-Xa=anti-factor Xa; aPPT=activated partial thromboplastin time; AT=antithrombin; PT=prothrombin time; TT=thrombin time

The **cobas®** t 711 coagulation analyzer cassettes had the highest test capacity for all assays, and a mean test capacity approximately three times higher than the reagent containers from comparator analyzers (**Table 3**). Onboard stability was longer for the **cobas** t 711 coagulation analyzer than comparator analyzers for all assays other than PT and TT; mean onboard stability of the **cobas** t 711 coagulation analyzer cassettes was approximately four times longer than the reagent containers from comparator analyzers. Since this study, the onboard stability for PT has been adjusted to 10 days after reagent vial reconstitution,[25] and the onboard stabilities of D-dimer and Anti-Xa reagents have increased to 84 days[24] and 14 days[23], respectively.

4. Advantages of the cobas t 711 coagulation analyzer

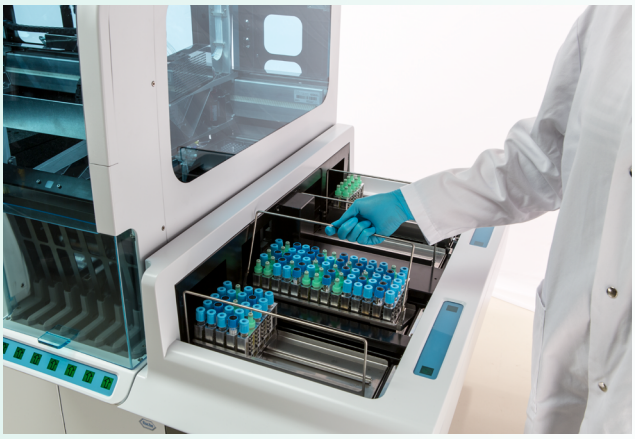
The **cobas** t 711 coagulation analyzer is a fully automated, continuous random-access, software-controlled system for clotting, chromogenic, and immunoturbidimetric analysis intended for the in vitro qualitative and quantitative determination of coagulation analytes in human citrated plasma. It offers ease of use, continuous operation, and maximized productivity while ensuring operator safety and reliable results to help support better patient care.

Previous studies have demonstrated the comparable analytical performance of the **cobas** t 711 coagulation analyzer compared with other systems.[8 14 26] There is a potential walk-away time of several hours with the **cobas** t 711 coagulation analyzer. This feature could be beneficial for all laboratories with regards to resource management and increased efficiency.[14] The rack system may additionally reduce hands-on time by laboratory personnel as it is possible to integrate analysis of different sample tubes in the racks; simplified sample preparation allows staff to move on to other procedures within the laboratory, potentially leading to improved workflow. A fully automated system that requires very little human intervention also offers a low risk of introduced errors.

The high processing power of the **cobas** t 711 coagulation analyzer enables laboratories to rapidly complete their daily testing workload. Although calibration and quality control processes can be more time-consuming than with other systems (**Table 2**), automated maintenance processes that require no hands-on time from laboratory staff can happen in the background and can be programmed to take place at night. By not encroaching on normal working hours, this allows staff to promptly commence their operations at the start of the working day.

Benefits of the cobas t 711 coagulation analyzer are enabled through:

Continuous loading/unloading of samples, reagents, consumables, and waste



Flexible sample tube handling:

- Open and closed sample tubes on the same rack
- Multiple tube vendors
- Automatic tube rotation

Sample integrity checks:

- Clog detection
- Hemolysis, icterus, lipemia index
- Full traceability of results

Automated reconstitution processes:

- Reagent reconstitution
- Scheduling of reconstitution

e-Services:

- e-Library access to download key information
- Laboratory Information Systems connectivity, and remote service support functionalities

5. Conclusions

Today's coagulation laboratories need to meet the increasing demand from clinicians for fast and accurate results and cost-effective solutions for many routine coagulation parameters. The innovative features of the **cobas** t 711 coagulation analyzer address the need for greater efficiency, improved workflow, and reliable results, potentially allowing laboratory staff to gain more time to focus on validation and clinical interpretation. For further information on the **cobas** t 711 coagulation analyzer, please visit: https://bit.ly/3HAgHOo

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COBAS is a trademark of Roche. All other product names and trademarks are the property of their respective owners. The **cobas** t 711 coagulation analyzer is not available in the US.

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Conflicts of interest

The authors are employees of Roche Diagnostics International.

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