Original Article

Evaluation of the Sakura GL II, a Novel Glucose Analyzer Intended for Point-of-Care Monitoring

Evaluation des Sakura GL II, eines neuartigen Glucoseanalysators für die „point-of-care"-Kontrolle

W. N. Kühn-Velten[1,2], F. Susanto[1], H. Reinauer[1]

Summary: The performance and practicability of an improved glucose analyzer using the immobilized glucose oxidase / H_2O_2 electrode technology, the Sakura GL II, was evaluated and compared to a fixed-time kinetic hexokinase method running on an Eppendorf Epos 5060 analyzer. Since the Sakura GL II measured glucose in the plasma compartment, whereas the Epos 5060 used hemolysates, results for 294 capillary blood samples were on average 11.3% higher with the Sakura GL II than with the comparison method. Glucose concentrations in serum samples certified for quality control surveys, however, were on average 8% lower with the immobilized glucose oxidase than with the hexokinase method. Mean within-run and between-day imprecisions (coefficient of variation) were 3.9 and 3.7% for the Sakura GL II and 1.7 and 3.0% for the Epos 5060 (n = 10). Since the Sakura GL II was assessed as very user-friendly, it appeared suitable for point-of-care glucose monitoring in the plasma compartment of capillary blood samples.

Keywords: Diabetes Mellitus; Blood Glucose/analysis; Blood Glucose Self-Monitoring/instrumentation; Glucose Oxidase.

Zusammenfassung: Die Leistungsdaten und die Praktikabilität eines neuartigen Glucoseanalysators, des Sakura GL II, wurden evaluiert. Das Gerät mißt Glucosekonzentrationen nach Umsatz mit immobilisierter Glucoseoxidase amperometrisch an einer H_2O_2-Elektrode; als Vergleichsmethode diente die kinetische Messung mittels Hexokinase / Glucose-6-phosphat-Dehydrogenase auf einem Eppendorf Epos 5060. Da die erste Methode im Plasmakompartiment, die zweite im Hämolysat mißt, waren die mit dem Sakura GL II ermittelten Glucosekonzentrationen im Mittel 11,3% höher als die Vergleichsmethodenwerte. Andererseits maß der Sakura GL II im Vergleich zum Epos 5060 Glucosekonzentrationen in Serumproben (Ringversuchsmaterial) durchschnittlich 8% zu niedrig. Die mittleren Unpräzisionen in der Serie bzw. von Tag zu Tag (Variationskoeffizienten) betrugen 3,9 bzw. 3,7% für den Sakura und 1,7 bzw. 3,0% für den Epos 5060 (n = 10). Da der Sakura GL II als sehr benutzerfreundlich und sicher in der Handhabung bewertet wurde, ist er zur „point-of care"-Kontrolle von Glucosekonzentrationen im Plasmakompartiment von Kapillarblutproben geeignet.

Schlüsselwörter: Diabetes mellitus; Blut-Glukose/Analytik; Blut-Glukose Selbstkontrolle/Geräte; Glucoseoxidase.

The increasing prevalence of diabetes mellitus as well as novel therapeutic strategies of intensive treatment increase the requirement of reliable blood glucose control in diabetic subjects [1-2]. In addition to fully automated systems which are normally reserved to central laboratories, various devices using either disposable strips or enzyme-generated electric signals have been developed in order to support point-of-care testing and self-monitoring of blood glucose levels [2-4]. Within both concepts, simplicity of both sample and instrument handling in addition to appropriate accuracy and precision of analytical results are mandatory.

In this evaluation report, the performance of a blood glucose meter, the Sakura GL II, which will be introduced to the European market in the near future, is described. This instrument had originally been developed for point-of-care quantification of venous blood glucose [5], but it could likewise be considered suitable for measurements of glucose concentrations in capillary blood samples.

Methods

Instrumentation and measuring principles

Test instruments of the Sakura GL II (manufactured by Daikin Industries, Shiga, Japan, and put on the market by Sakura Finetek Europe, Zoeterwoude, The Netherlands), which represents the improved version of the previous Antsense (Daikin - Bayer Sankyo) analyzer,

[1]Diabetes-Forschungsinstitut an der Heinrich-Heine-Universität Düsseldorf, Abteilung für Klinische Biochemie
[2]Correspondence to: Prof. Dr. W. Nikolaus Kühn-Velten, Diabetesforschungsinstitut an der Heinrich-Heine-Universität, Abteilung für Klinische Biochemie, Auf'm Hennekamp 65, D-40225 Düsseldorf. Fax: +49-211-3382-603
Received: May 6, 1998 / Accepted: July 6, 1998

were kindly provided by PFM (Cologne, Germany). The principle of measurement is as follows: A drop of blood is applied to a cell separation filter on a cartridge film. Upon starting, the film is automatically drawn over a diffusion limiting membrane set to the electrode. Glucose in the cell-free compartment of the sample is converted to gluconolactone and hydrogen peroxide by membrane-bound glucose oxidase. Decomposition of H_2O_2 on the surface of a platinum (anode) - silver (cathode) electrode generates a current which is detected and converted to glucose concentration on the basis of previous calibration with an aqueous glucose standard. The instrument is supplied with a transformer and rechargeable batteries, and there is a built-in memory for up to 99 results.

As the comparison method, coupled hexokinase-catalyzed glucose phosphorylation and glucose-6-phosphate dehydrogenase-calalyzed NADPH generation (fixed-time kinetic method at 37 °C, absorption measurement at 334 nm, incubation time 4 minutes, cycling time 12 s) was implemented on the Epos Analyzer 5060 (Eppendorf, Hamburg, with reagents from Boehringer Mannheim. Routinely, hemolysates (prepared by mixing 20 μl capillary blood with 500 μl of a solution containing 50 mg digitonine + 100 mg maleinimide / l) were analyzed.

Samples

Capillary blood was obtained from in- and out-patients of the Diabetes Research Institute Düsseldorf in random order. Samples were subjected directly (i.e., within 10 minutes) and simultaneously to analysis by the Sakura GL II (whole blood) and the Epos 5060 (hemolysates). Investigations on accuracy and precision were performed using certified serum controls manufactured by Chiron Diagnostics (sample A), Roche (B), Merck (C), Miditron (D) and Boehringer Mannheim (E). These materials had previously been used in external quality assessment surveys. After appropriate reconstitution, samples were either applied directly to the Sakura GL II or diluted (1:26) with hemolyzing solution for analysis on the Epos 5060. Aqueous glucose standards (F to K; 50, 100, 150, 200, 300 and 400 mg glucose / dl; Preciset Glucose, Boehringer Mannheim) were characterized in the same way.

Reference method

After the method comparison study with whole blood, seven additional consecutive patient samples were subjected to parallel analysis on the Epos 5060 (see above) and by isotope dilution gas chromatography - mass spectrometry as the established reference method [6]. In order to minimize isotope effects, capillary blood was diluted only 1:6 with the hemolyzing reagent. After addition of [U-^{13}C]glucose as internal standard, glucose was converted into its aldonitril pentaacetate derivative using hydroxylamine and acetic anhydride. Gas chromatography was performed on a Hewlett-Packard 5890A gas chromatograph (Avondale, PY, USA) equipped with a 13 m x 0.18 mm (i.d.) DB-1 column (J & W Scientific, Folsom, CA, USA) and a cold injection system (KAS) from Gerstel (Mülheim, Germany). Mass spectra were recorded at an electron energy of 70 eV and flame emission current of 0.7 mA on an INCOS 50B mass spectrometer system (Finnigan MAT, San José, CA, USA). Data acquisition, reduction and selected ion monitoring were performed under software control by the DG10 system of Data General (Wesboro, MA, USA). Peak abundances of fragmentation mass to charge ratio (m/z) 314 for unlabelled and 319 for labelled glucose were monitored for calculation of the plasma enrichment of the isotope.

Evaluation procedure and statistics

As suggested by the European Committee on Clinical Laboratory Standards [7], the method comparison on the basis of patient samples was evaluated with the standardized principal component analysis as described in [8]. For characterization of within-run imprecision, quality control samples were analyzed in segments of ten consecutive measurements; between-day imprecision was characterized by duplicate analyses on ten days [7]. Specimen-related carry-over ratios K were calculated from ten repetitive triplicate analyses of low (L1 to L3) and high (H1 to H3) aqueous glucose standards (50 and 400 mg/dl) as K = (L1 - L3) / (H3 - L3) [7].

Results

The comparison of glucose concentrations in 294 patient samples analyzed with the EPOS 5060 in capillary blood hemolysates and with the Sakura GL II in whole capillary blood yielded a non-identical function (Fig. 1). Means of the x-field and of the y-field were significantly different at the $P < 0.01$ level, and the slope of the standardized principal component was significantly different from 1 with $P < 0.0001$. However, no systematic deviation from linearity was observed within the measuring range. To assess the accuracy of glucose concentration measurements in hemolysates, patient samples were drawn and analyzed in parallel with the hexokinase method and with isotope dilution-mass spectrometry. The deviation of results of the former method from reference method values was - 1.18 $\pm$ 6.98% (mean $\pm$ SD; n = 7), indicating that analyses with the EPOS 5060 system gave correct results. Since the differences between the hexokinase and immobilized glucose oxidase methods were at first attributed to different water fractions as the consequence of different sample processing, characterization of accuracy and precision was performed with both serum material and aqueous glucose standards in order to obtain further information on possible matrix effects on analytical results.

Analysis of five serum samples certified for use in external quality control programs, which had been obtained from different manufacturers, resulted in aver-

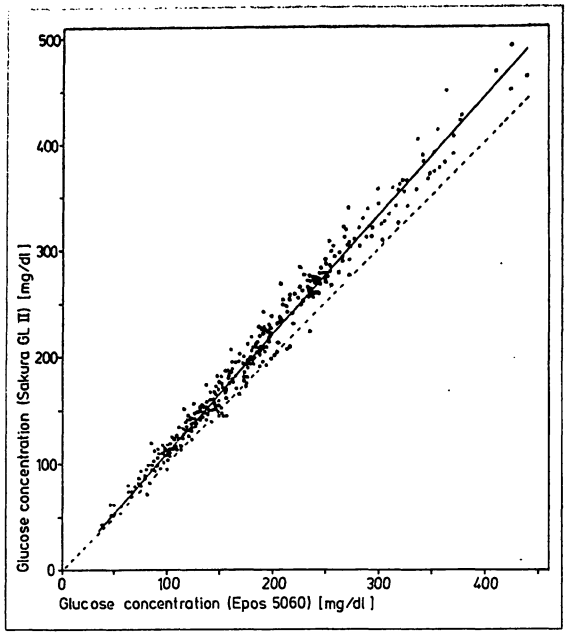

Figure 1 Method comparison between Sakura GL II (ordinate) and Epos 5060 (abscissa). The characteristic measures are as follows: n = 294; X-min = 38, X-max = 439, X-mean = 188.1, Sx = 80.8; Y-min = 42, Y-max = 491, Y-mean = 208.5, Sy = 90.0; principal component analysis: slope = + 1.1131, y-intercept = - 0.812, Sx.y = 9.056. The solid line is the resulting function, and the broken line is the theoretical line of identity

age within-run coefficients of variation of 3.94 ± 1.28% and 1.70 ± 0.74% (mean, SD, n = 5) for the immobilized glucose oxidase and hexokinase methods, respectively. The corresponding mean between-day coefficients of variation were 3.68 ± 1.27% and 2.96 ± 1.13%, and the total coefficients of variation were 5.39% and 3.41%, respectively, for the two methods. Imprecision appeared to be much more dependent on sample type than on assigned glucose concentrations (Table 1). With these serum controls, the mean deviation of results from reference method values was - 2.97 ± 3.59% of RMV for the hexokinase method implemented on the EPOS 5060; however, the corresponding deviation for the Sakura GL II using the glucose oxidase method was as high as - 11.28 ± 3.05% (Table 1).

Using aqueous glucose standards at six different concentrations, between-day coefficients of variation were 2.16 ± 0.54% (mean ± SD, n = 6) for the hexokinase and 2.04 ± 0.45% for the immobilized glucose oxidase methods, respectively (Table 2). Deviations from assigned values were + 0.52 ± 2.16% for the former and + 12.85 ± 5.78% for the latter procedure. Further analyses revealed that both methods were linear in the 50 to 400 mg/dl concentration range; however, slopes of the regression lines were significantly ($P < 0.01$ for the Epos 5060 and $P < 0.0001$ for the Sakura GL II system) different from 1, whereas the ordinate intercept was different from zero only with the Sakura GL II ($P < 0.02$) but not with the Epos 5060 (Table 2).

Table 1 Assessment of accuracy and imprecision (n = 10) of glucose analysis in quality control sera by the Sakura GL II (immobilized glucose oxidase) and the Epos 5060 (hexokinase)

Sample	A	B	C	D	E
Reference method value (RMV) (mg/dl)	44.6	76.0	111.0	239.0	245.0
Within-run imprecision					
Sakura GL II					
Mean value (mg/dl)	39.4	68.0	98.1	225.5	218.0
CV (%)	5.89	4.28	3.91	2.60	3.01
Difference from RMV (%)	- 11.21	- 10.53	- 11.62	- 5.65	- 11.02
Epos 5060					
Mean value (mg/dl)	46.4	72.1	105.6	241.4	242.7
CV (%)	2.72	1.37	0.80	1.49	2.11
Difference from RMV (%)	+ 4.04	- 5.13	- 4.86	+ 1.00	- 0.94
Between-day imprecision					
Sakura GL II					
Mean value (mg/dl)	37.4	64.2	93.3	213.1	234.4
CV (%)	5.08	4.86	3.19	2.05	3.21
Difference from RMV (%)	- 16.14	- 15.53	- 15.95	- 10.84	- 4.33
Epos 5060					
Mean value (mg/dl)	43.3	69.5	101.2	232.9	242.8
CV (%)	1.90	3.48	2.32	4.69	2.41
Difference from RMV (%)	- 2.91	- 8.55	- 8.83	- 2.55	- 0.90

There was no significant specimen-related carry-over with aqueous glucose standards in either system; the ratios amounted to K = + 0.0027 ± 0.0028 and K = + 0.0008 ± 0.0043 (means ± SD; n = 10) for the hexokinase and the immobilized glucose oxidase methods, respectively. Similarly, the long-term drift was less than 2% at three different glucose concentrations (50, 150 and 400 mg/dl) within 8 hours after initial calibration and could therefore be neglected.

Overall practicability of the Sakura GL II is good. Results are indicated within 45 seconds from sample application; this period includes automatic washing and regeneration of the system. No problems as to the technical reliability were recognized. Even without time-consuming staff training, procedural errors compromising accuracy is very low. Attention is required not to injure the membrane by the glass capillaries, to avoid air bubbles in the sample, and to completely cover the film area with sample (10 µl were sufficient). There is automatic indication of the need for changing film cartridge (the remaining number of analyses still possible with a single cartridge is always indicated) or buffer tank and for recalibration, though additional manual recalibration can be performed at any time desired. Blood measurements cannot be performed if the system is not calibrated; on the other hand, the system can not be calibrated if the calibrator solution bottle remains in its storage compartment. There is no highly toxic waste. Since the system has not yet been commercially introduced on the European market, aspects of its economy of operation cannot be considered at present. Analysis of one glucose sample with the Epos 5060 costs (without amounts for investment and personnel, but including maintenance and calibration materials) DM 0.14 at a frequency of 12500 analyses / month.

In conclusion, the Sakura GL II appears to be suitable for point-of-care monitoring of blood glucose levels in diabetic patients; it is very user-friendly, and the imprecision of the results is low. It is strongly recommended, however, that potential customers realize the possibility of differences (dependent on sample processing) with certain routine methods in a clinical chemistry laboratory.

Discussion

Previous evaluations of the Sakura GL II in Japanese laboratories investigated its performance with venous blood samples. The results were reported to be in good agreement with instruments also using the immobilized glucose oxidase technology, there were good correlations even in the hypoglycaemic range (> 20 mg/dl), and the measurements had been shown to be insensitive towards differences in relative oxygen saturation of the samples [5]. Since, however, venous blood is not the preferred material for point-of-care glucose testing at least in Germany, the present report focuses on the quality of analytical results in comparison to the hexokinase method using capillary blood.

The systematic differences between results obtained with the hexokinase method (Epos 5060) and the immobilized glucose oxidase method (Sakura GL II) raise the question as to the relevant blood compartment in which glucose concentrations are quantified. The hexokinase method on the Epos 5060 as the comparison procedure uses capillary blood hemolysates; therefore, possible glucose concentration gradients between intra- and extracellular compartments as well as differences between intra- and extracellular protein concentrations and water contents are abolished. On the other hand, the material applied to the Sakura GL II using the immobilized glucose oxidase technology was whole capillary blood, which was separated into the cell and aqueous compartments by a built-in filter

Table 2 Assessment of accuracy and between-day imprecision (n = 10) of glucose analysis in certified aqueous standards by the Sakura GL II (immobilized glucose oxidase) and the Epos 5060 (hexokinase)

Sample	G	H	I	J	K	L
Reference method value (RMV) (mg/dl)	50	100	150	200	300	400
Sakura GL II						
Mean value (mg/dl)	51.6	109.8	169.7	229.7	348.8	479.3
CV (%)	2.44	1.91	1.52	1.56	2.31	2.53
Difference from RMV (%)	+ 3.20	+ 9.80	+ 13.13	+ 14.85	+ 16.27	+ 19.82
Regression of y on x where x = RMV: y = - 12.13 + 1.218 x; r = + 0.9998						
Epos 5060						
Mean value (mg/dl)	48.9	99.2	149.8	200.9	305.5	415.9
CV (%)	2.80	1.56	2.11	1.86	1.82	2.84
Difference from RMV (%)	- 2.20	- 0.80	- 0.13	+ 0.45	+ 1.83	+ 3.98
Regression of y on x where x = RMV: y = - 6.01 + 1.047 x; r = + 0.9998						

device prior to glucose quantification in the latter fraction. It is generally accepted [2] that capillary plasma glucose concentrations are constantly 14% higher than whole capillary blood glucose levels (range: 50 to 330 mg/dl). Since calibration of the Sakura GL II was based on plasma samples, that difference provides the principal explanation for the result that glucose concentrations indicated by the Sakura GL II are on the average by 11% higher than equivalent values obtained with the Epos 5060 system (Fig. 1). It must be emphasized that previous evaluations of the Sakura GL II compared its function solely to so-called reference instruments that use the same technology. As the consequence, system-dependent variations have not yet been described. In clinical practice, it is therefore important to realize such methodological factors when comparing results from point-of-care monitoring and those from the central clinical laboratory.

The fact that glucose concentrations in aqueous control samples are constantly over-estimated is easily explained. The instrument is calibrated with an aqueous solution containing 150 mg glucose/dl (this declaration was controlled during this evaluation study and found to be correct). According to information given by the manufacturer, the electronic signal is then converted to an indicated glucose concentration $y = (x - 4.6) \times 1.20$ where x is the true value. This formula, which was (as communicated by the manufacturer) originally empirically derived from comparisons of blood analyses with the Sakura GL II and control measurements in centrifuged plasma samples, is similar to the relation $y = (x - 9.9) \times 1.22$ established with aqueous standards in the present study.

On average, glucose concentrations in plasma samples are constantly underrated by 8% by the Sakura GL II as compared to the Epos 5060 system. The 11% underestimation of glucose concentration in comparison to reference method values is within the accepted $\pm$ 15% range [9]. Though the Sakura GL II is not intended to be used for analyses of serum samples, problems might nevertheless arise if this instrument is subjected to external quality assessment surveys since these programs normally provide lyophilized serum materials.

Both within-run and between-day imprecisions of the Sakura GL II are low and well below the limits recommended in a recent consensus statement [3]. Long-term drifts and carry-over effects were not registered or can be neglected.

Acknowledgement

We would like to thank Mr. *A. Gorzalek*, PFM Köln, for supplying the equipment and reagents used in this evaluation as well as for constructive discussions. Thanks are also due to Dr. *R. Hanke*, Instand e.V. Düsseldorf, for support. We are especially grateful to the technical staff at the central laboratory of the Diabetes Research Institute Düsseldorf, in particular Ms. *I. Latta* and Ms. *S. Breitwieser*, for assistance.

References

1. The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Report of the Expert Committe on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care 1997; 20: 183-97.
2. Burrin JM, Alberti KGMM. What is blood glucose: Can it be measured? Diabetic Med 1990; 7:199-206.
3. Arens S, Moons V, Meuleman P, Struyf F, Zaman Z. Evaluation of Glucocard Memory 2 and Accutrend Sensor blood glucose meters. Clin Chem Lab Med 1998;36:47-52.
4. Bachg D, Reinauer H. Der economic Glucoseanalyzer - Evaluationsergebnisse. Lab Med 1995; 19: 463-6.
5. Mashiko A, Kusano T, Endo A, Sasagawa Y, Kohno R, Watanabe M, Abe R. Clinical evaluation of improved portable glucose meter Antsense II. Med Pharm 1996; 35:921-8.
6. Stöckl D, Reinauer H. Candidate reference methods for determining target values for cholesterol, creatinine, uric acid, and glucose in external quality assessment and internal accuracy control. I. Method setup. Clin Chem 1993;39:993-1000.
7. European Committee for Clinical Laboratory Standards. Guidelines for the evaluation of analysers in clinical chemistry. ECCLS Document Vol.3 No.2. Berlin(DE): Beuth Verlag, 1986:1-32.
8. Feldmann U, Schneider B, Klinkers H, Haeckel R. A multivariate approach for the biometric comparison of analytical methods in clinical chemistry. J Clin.Chem Clin Biochem 1981;19: 121-37.
9. Qualitätssicherung der quantitativen Bestimmungen im Laboratorium. Neue Richtlinien der Bundesärztekammer. Dt Ärztebl 1988;85:A697-712.

Red Cell Transfusion: A Practical Guide. Marion E. Reid, Sandra J. Nance. New Jersey: Humana Press, 1997, 232 S., gebunden. $ 99.50. ISBN-Nr. 0-89603-412-7.

Das Buch bietet eine ausführliche Darstellung der klinischen Transfusionsmedizin mit Schwerpunkt auf der Applikation von Erythrozyten. Ausgehend von einem kurzen aber kompetenten Überblick über die Immunhämatologie und die laboratoriumstechnischen Aspekte der Transfusionsmedizin werden kritische Konzepte zur klinisch-transfusionsmedizinischen Patientenversorgung bei den verschiedensten Patientengruppen entwickelt: Transfusion bei Autoantikörpern, beim immunsupprimierten Patienten, in der Perinatalmedizin und der Pädiatrie, in der Transplantations- und der Notfallmedizin sowie bei der Substitution chronisch transfusionsbedürftiger Menschen. Daneben wird auch der Aspekt der Eigenbluttransfusion erörtert. Besonders bemerkenswert ist auch die kritische Diskussion der Transfusionstrigger.

Der Wert des Buches wird gesteigert durch die ausführlichen Literaturhinweise am Ende eines jeden Kapitels.

Das Buch richtet sich in erster Linie an den Transfusionsmediziner und unterstreicht die klinische Implikation des Faches. Es ist aber auch von Bedeutung für Ärzte anderer Fachrichtungen, die viele Transfusionen durchführen, zumal die für den Fachfremden oft schwierige Materie in gut verständlicher Form dargestellt ist. Es sollte daher seinen Platz in der Klinik finden.

Prof. Dr. *R. Eckstein*, Erlangen
Friedrich-Alexander-Universität Erlangen-Nürnberg
Abteilung für Transfusionsmedizin und
Hämostaseologie

EBM - Laborreform
Kur oder k.o.?

Herbsttagung des Berufsverbandes
Deutscher Laborärzte e. V. (BDL)
am 25./26. September 1998 in Würzburg

Programm

Freitag, 25. September 1998

15.00 Uhr	Sitzung des geschäftsführenden Vorstandes des BDL
17.00 Uhr	Sitzung des Gesamtvorstandes des BDL
20.00 Uhr	Gemeinsames Abendessen der Tagungsteilnehmer - anschließend geselliges Beisammensein (Reservierung erforderlich)

Samstag, 26. September 1998

10.00 Uhr	Begrüßung und Eröffnung Dr. *C.-H. Lippelt*, 1. Vorsitzender BDL
10.15 Uhr	„Forderungen an eine Laborreform" Prof. Dr. med. *Hans Rodt*, Rosenheim
10.40 Uhr	„Weiterentwicklung des Laborsystems" Dr. med. *Joachim Stumpp*, Mc Kinsey & Co
11.05 Uhr	„Sachbestandsbericht zur Reform des Labors im EBM" Dr. med. *Andreas Köhler*, Leiter des Dez. 3 der KBV
11.30 Uhr	„Die Laborreform im Umfeld aktueller Gesundheitspolitik" Dr. med. *Eckhard Weisner*, 2. Vorsitzender der KBV und Präsident der ÄK Schleswig-Holstein
12.00 - 12.15 Uhr	Pause
12.15 - 13.30 Uhr	Diskussion
13.30 - 14.00 Uhr	Mittagsimbiß
14.15 Uhr	Jahreshauptversammlung des BDL
20.00 Uhr	Geselliges Beisammensein

Veranstaltungshinweise:
Veranstaltungsort: Congress Centrum Würzburg/MARITIM Hotel Würzburg, 97070 Würzburg.
Telefon: 0931/3 05 30; Telefax: 0931/3 05 39 00.

Bei der Vermittlung von Übernachtungsmöglichkeiten ist auf individuelle Anfrage behilflich: Congress & Tourismus Zentrale, 97070 Würzburg, Am Congress Centrum.
Telefon: 0931 37 23 55 u. 37 23 56; Telefax: 0931 37 36 52.

Teilnehmergebühr: BDL – Mitglieder 250,00 DM, Assistenten (Weiterbildung) 100,00 DM, andere Teilnehmer 350,00 DM. Hinweise zur Anreise: PKW: 300 Tiefgaragenstellplätze im Congress Centrum. Bei Rückfragen wenden Sie sich bitte an den
Veranstalter: Berufsverband Deutscher Laborärzte, Berliner Allee 32, 40212 Düsseldorf, Telefon: 0211 13 23 63; Telefax: 0211 13 25 22.

