THE EUROPEAN SOCIETY OF MEDICINE
Medical Research Archives, Volume 14 Issue 5

RESEARCH ARTICLE

# A pre-diabetes case concerning metformin assumption to avoid progression to full disease

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OPEN ACCESS

**PUBLISHED**
31 May 2026

**CITATION**
Pavese, F., 2026. A pre-diabetes case concerning metformin assumption to avoid progression to full disease. Medical Research Archives, [online] 14(5).



**ISSN**
2375-1924

## ABSTRACT

Pre-diabetes is commonly considered a preliminary form of (full) diabetes, which can be delayed to occur later in life by the prescription of daily administration of metformin in addition to personal training through diet and other glucose-reducing general rules.

The Author found himself in such a situation after an infection during a foreign travel, damaging his pancreatic functions and bringing his glucose level quite above 125 mg/dL. He was immediately prescribed a diet and the administration of a brand of metformin. It was assumed for about 8 years until this brand of metformin became commercially unavailable: his previous publications on this subject matter have shown how glucose level was subsequently maintained in the range below 125 mg/dL without exceptions, according to frequent home tests and also according to an annual professional test.

Recently, the author had to change the kind of metformin due to the lack of the former, but he had evidence of some of the problems that are indicated in the literature as typical of this assumption, namely diarrheal. This fact prompted the author to also check whether, in his case, the assumption of metformin was possibly non-strictly needed.

The present case is reported here with the results of a test period of a ≈5 months without interruption, after a month where alternated weeks with and without assumption were spent for a quick observation of the possible differences in the effects. This kind of case strictly requires the use of the methodology the author has developed to perform the home tests: it consists mainly of an extremely careful and frequent recalibration of the tools used in the home tests, strips and testers. He is assuming to be a valid and necessary precaution for studying these types of cases, developed during his very long professional career in Measurement Science and specifically in Metrology.

The results of the study on this case are expected to allow for a forecast over the longer term without need to get a statistics longer than a few months, highlighting two main issues: when combined with a healthy lifestyle, metformin can help patients maintain a stable blood glucose level, even below 100 mg/dL; additionally, the administration of metformin was not necessarily needed to avoid an increase in blood glucose levels above 125 mg/dL over time.

Not being a medical doctor, the author cannot make a general statement about the lack of need for assumption of metformin. The author also found in his case that assumed metformin immediately brought the glucose level even below 100 mg/dL, which can be considered a non-necessary though safer situation—this was also an occasional case for the previous metformin type. On the other hand, this may also indicate that a correct diet and personal training may be sufficient to prevent pre-diabetes.

## 1. Introduction

Pre-diabetes is commonly considered a preliminary form of (full) diabetes, the latter being possibly delayed to occur later in time by the prescription of daily administration of metformin in addition to personal training by means of a diet and other glucose-reducing/limitation general rules.

The Author found himself in such a situation after an infection almost 10 years ago during a foreign travel, damaging his pancreas and bringing his glucose level quite above 125 mg/dL [1]. He was immediately prescribed a diet and the daily assumption of a type of metformin was assumed by him during about 8 years until this kind of metformin was not anymore commercially available: in previous publications [1–6] he already showed how glucose level was subsequently maintained in the range below 125 mg/dL without exceptions, according to frequent home tests and also to an annual professional test (see in Table 1 the comparison between hospital professional tests and author's home tests).

**Table 1.** Glycaemia levels since pre-diabetes start. Mean values since 2018: Hospital: plasma 115 mg/dL; capillary 104 mg/dL. Home: capillary (108 ± 5) mg/dL.

| Date | From Plasma/Capillary (hospital) | Capillary (author mean ± s.d.) |
|---|---|---|
| jun-2016 | 125/113 | |
| jul-17 | *145/131* | |
| oct-18 | 124/112 | *140*—**95** ±4 |
| mar-19 | 117/105 | 105 |
| oct-19 | 114/103 | **94—100** ±4 |
| aug-20 | 110/**100** | 103—108 ±3 |
| jun-21 | 121/109 | 108—115 ±4 |
| nov-21 | *128*/115 | 110 |
| jul-22 | **91**/**82** | 108—111 ±4 |
| jan 23 | 110/**100** | 109—110 ±4 |
| dec-24 | | 107—104 ±5 |
| oct-2025 | | 104 ±7 |
| oct-2025 | 118/106 | |
| nov-2025 | | 110 ±9 |
| dec-2025 | | 108 ±10 |
| jan-2026 | | **100** ±7 |

*Italics*: full diabetes; **Bold**: no diabetes; s.d. = abbreviation for standard statistics.

Recently, the author had to change the kind of metformin due to the lack of the former, but he had evidence [a] of some of the problems that are indicated in the literature as typical of this assumption, namely diarrheal—though it rarely occurred to him in the past with the previous brand of metformin, though he had an irritable colon since his young age.

This fact prompted the author to also check whether *now* the assumption of metformin was possibly non-strictly needed.

A large literature is available on the issue of metformin usefulness, with pros and cons: the References 7–11 was chosen to show for different positions/opinions about the benefits or dangers or risks in discontinuing the assumption of metformin (in Ref. 11 even having the risk for an abbreviated lifetime).

In the present case is thus reported now to show the results of a test period of full *5 months without interruption, indicating without doubt* that the assumption of metformin was not necessary to keep the patient pre-diabetic condition stable in time—this was obtained following a month where alternated weeks were spent with and without assumption for a quick observation of the possible differences in the effects (see later the comments on Fig. 1).

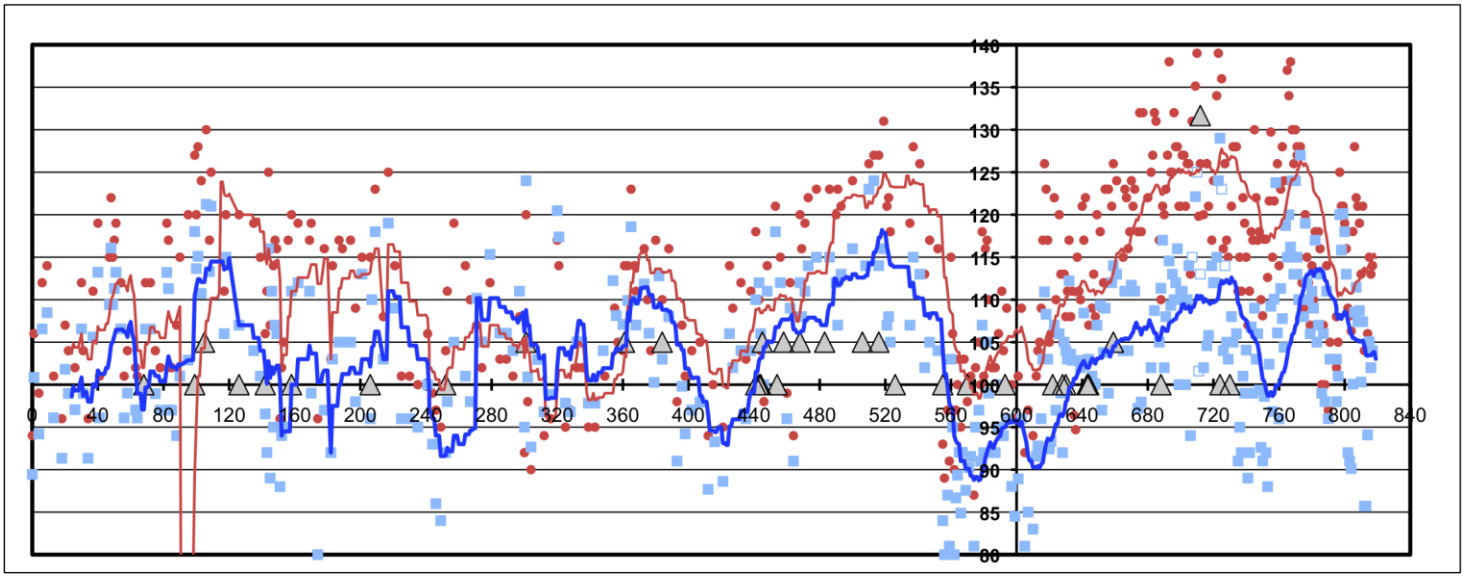


**Fig. 1.** Latest example of home tests: from January 2025 to middle December 2025. Trend curves are for running mean of 25 data. Concentration is shown in mg/dL *vs* test #.
Pre-diabetes: lower limit (no disease) 101 mg/dL; upper limit (full diabetes) 125 mg/dL.
Red symbols and line: *uncalibrated*, (single drop to zero at #90: no test). Blue symbols and line: *calibrated*.
Gray triangles: @"100" *time* of strip-batch change; @"105" same for strip batches found with up to ≈10% higher-value indications.

## 2. The used measurement method

The study of this kind of case strictly requires the use of the methodology developed by the author to perform home tests since some years after the occurrence of the disease, and published [1–6]: it basically consists in an extremely careful and frequent *recalibration* of the commercial tools used for the home tests, strips and testers. After further comparison with professional tests in [5], he assumed that it is a valid and necessary precaution for this type of case: this method has been developed based on his very long and qualified professional career in Measurement Science and specifically Metrology. In this Section author's method used for home tests is first summarised.

Shortly after the beginning in 2016 of their use, the author noticed that not all *strip batches* have a middle value of the "valid range" (reported on the box) equal to 140 mg/dL, the value considered the *reference* one for batched used in pre-diabetes, i.e. the one of a batch matching the "control solution" [b] value for the "Range 3"—so being called the range concerning pre-diabetes. Therefore, e.g., for the middle value 142 mg/dL, a correction of 1.0143 is needed; consequently, the author applied a corresponding *correction* to the readings.
Even after the calibration of the strip batches since 2018, only since *January 2024,* the author had also to realise that the *tester* itself, used as the measuring instrument of the strips, was *not (always) calibrated*. Therefore, the tester was also *calibrated* since *April 2024* by using strips and the control solution supplied by the manufacturer.

The basics of the home-test measurement procedure for the pre-diabetes range and the home testing apparatus consists of: A) Strip tests & Lancets; B) Tester of the strips; C) Control solution (formally a *Reference Material*) for equipment calibration.

A) Strip tests & Lancets
They are usually sold in boxes of 25 units, characterised by a series number and dates of manufacturing & validity and by a range of validity of the strips, with the middle value of the range reported.

The latter is not necessarily the "nominal" value of the range for all batches: if not, the readings *must require a correction* to the nominal value of the range, in pre-diabetes, 140 mg/dL.

B) Tester of the strips
Each manufacturer provides at least a tester for the pre-diabetic range. The measurement consists of inserting a strip of the current batch in the tester slot and of making it adsorb some blood (capillary blood, i.e. "full" blood) from a drop obtained with the puncture of a lancet, generally (but not only) a finger (of the hand recently cleaned and dry).

If more than one test has to be done, one can use the same lancet up to 2-3 times (better only once if the measurements are not performed in a very short time interval). If more than one sample is used, only one puncture per finger has to be done.

Test(s) has to be done before any fasting (including liquids) or physical exercise, during the first hour after getting up in the morning, typically in the interval 8-9 a.m. (glucose level will increase during the day).
The tester can provide the glucose level value in two different ways:

1) When measuring capillary blood (the provided drop), use the indicated level value.
2) If measuring blood plasma—normal from professionals (hospitals, labs)—as the use of the test is assumed to be for capillary blood, one has to divide the reading by 1.11.

3) The tester cannot be assumed to be calibrated even if just taken off shell. *The tester must be (re)calibrated frequently*: for the current measurement, use only your last re-calibration, not any older one, typically closer than 2 months or 10 times after it was used for tests. The calibration needs to use the Control Solution provided by the manufacturer.

C) Use of the Control Solution
The Control Solution is usually contained in a small bottle containing 2.5 mL of it. It contains a given concentration of glucose in a liquid intended to preserve the stability with time of the glucose concentration.

The manufacturer's indications report the date of preparation and the date of expiration. Internationally, it is called a "Reference Material", subjected to specific International Standards, containing detailed standard instructions for its preparation by the manufacturer and how to assign a "nominal value" and "accuracy" to the represented value. These two latter requirements are usually not met for these control solutions: only the name of the range of intended use is indicated, with *no* precision/accuracy, nor its nominal value.

One has to assume that the same nominal value is valid for the strips (140 mg/dL for "Range 3" pre-diabetes).
The user has to (re)-calibrate the tester by using a drop of *solution* from the bottle with one of the strips of the *current* batch.

To extract the drop, it is advised to first shake the bottle for a while (sometimes not recommended by the manufacturer), to restore solution homogeneity, then a first drop is eliminated and the second is put on the bottle plug cap, clean and dry.

If one decides to repeat the measurement, by changing the strip to check for reproducibility, it must be considered that the strips in the batches necessarily have a dispersion in their indicated values, even if the solution provides the same value; that is, a *lower limit* for the tester calibration *precision*.
If the tester indication is different from the "nominal value" assumed to be 140 mg/dL (see above), a *correction* must be applied to its indication.

D) Measurement value and its precision
The patient's blood drop measured value *M* must therefore be corrected as follows:
$M$ = (tester-correction × strip-correction)/1.11 if the tester is measuring plasma value).

Only *precision* can be obtained since *no information* is available about the *accuracy* of the strips (and of the tester itself). Other uncertainty components might arise from the operation of testing and from the expertise of the operator (the patient): no way to estimate them, except by possibly repeating the test if it looks unreliable. It may be possible to *infer* if a strip batch is providing abnormally high or low values only when the mean of the batch results is outside a dispersion band of about 10%. In most cases, the measured values are found lowered by the correction.

In Fig. 5 the dispersion of the obtained calibration corrections in the full period is reported: 0.878 ± 5.6%. It corresponds to the dispersion of the glucose-level measured values in the same period, indicating that the dispersion has to be attributed to the general measurement imprecision (strips + tester).
As shown here in Fig. 1 for calibrated/un-calibrated measurements, a difference of the order of 10% [c] was found, *substantial for the pre-diabetic* **range** *only wide* 25 mg/dL, a ± 12.5%.

## 3. Observed metformin effects

In Ref. 2, Fig. 1 is showing the whole comprehensive behaviour measured since the start of daily assumption of a metformin type in 2016—the same then up to 2023. The problems found after a short use of a *new* metformin type are instead summarised *here* in Fig. 1 (after test #560), with an observed lowering of glucose level even down to about 80 mg/dL after a few days of administration.

From Fig. 1 in Ref. 1 one can also appreciate, after the initial effects of the antibiotics immediately prescribed in March 2016 to restore pancreas functionality during the first full month, the effect of the immediate daily assumption of the initial type of metformin, then continued until 15 July 2025—as indicated by a few obtained professional tests and by the frequent home tests.

The latter are also shown corrected after home measurement apparatuses re-calibration. [1] Unfortunately, it was not possible now to check the effect of that metformin type on the glucose concentration level, as its production was unexpectedly stopped and the assumption of a new metformin type started already 3 days later (see *here* in Fig. 1). The use of the new metformin type was performed intermittently and only for a short period (50 tests from July 19 to October 8, 2025 shown here in Fig. 1).

The observed preliminary effect was quite significant, producing a very strong reduction of glucose concentration, also reaching *for a few day* values below 100 mg/dL down to about 80 mg/dL—i.e. reducing the patient's health status to below the lower limit of diabetes condition, quite outside the intended prescription intention (being it mainly that to avoid an increase above the upper limit of 125 mg/dL).

The more recent observations, brought also the author to re-consider a previous behaviour observed during the 8-year assumption of the initial metformin type—one especially having occurred in 2024 and shown in the left part of Fig. 1: an oscillation-like behaviour in time of the glucose concentration, with *periodic* increases followed by decreases even below 100 mg/dL, which might be attributed to metformin, except for the periodicity reason. The same behaviour can also be noted in Fig. 1 of Ref. 1 when looking at the full period of assumption started in 2016, and a general tendency of the corrected (bi-monthly) data to move toward a bit lower values: this

might be attributed to a long-term effect of metformin. Anyway, it was a *minor effect* with respect to the one presently observed effect for the last type of metformin, here in Figs. 1—3.

## 4. No-metformin assumption: a continuous 5 months tests case

It is quite difficult to assume the possibility a potentially functional recovery of the pancreas from a pre-diabetes condition having lasted several years, merely due not to a metabolic disease but to a pancreatic insult. Therefore, the author decided to check whether his assumption of metformin was actually necessary for keeping his pre-diabetes within the limit of 125 mg/dL—i.e., by not assuming *any drug* but only relying on the diet. The latter is of the Mediterranean type and consists of: a lack of morning fasting; a normal lunch with meat, some fruits, but no sweets of any kind later in the afternoon; finally, a dinner made of vegetables, cheese, and no fruits; some wine while eating and 10 mL of liquor after dinner; limited physical exercise.

The only lack of *physical* effect of the new type of metformin has been observed to be an increase in body weight of about 1 kilogram in total—after having lost some kilograms of weight while assuming the first type of metformin: at the beginning of its assumption, it was 74 kg, at the end 68 kg (during the no-metformin period, it was initially 65 kg, final 67.5 kg max).

The present results of the test are reported in Figs. 2—4, where only two exceptions to regular trend have to be noted: (a) one week of trial assumption of an inhibitor of protonic pump instead of the usual Maalox to avoid the gastro-reflux affecting the author since a couple of years, producing a sudden *lowering* of the glucose concentration by ≈ 10 mg/dL; a week spent in another town without the possibility to keep care of the usual diet, producing an *increase* of ≈ 10 mg/dL (during the end-of-year holydays a more irregular trend was due to the difficulty to strictly control the diet …). As evident from Figs. 1-2, the inhibitor of protonic pump had a (milder) effect similar to the metformin one, while a moderate lack of the usual diet induced an increase in the glucose level within about 10%. The recovery to the usual conditions was, in general, almost immediate.
For full details see also Figs. 1—4 captions.

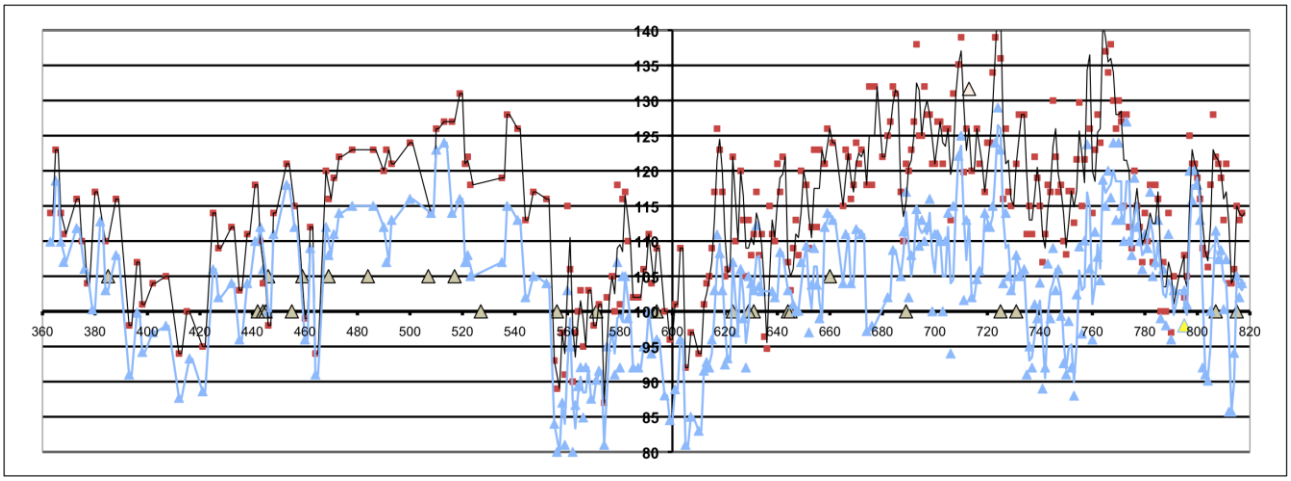


**Fig. 2.** Home tests from middle 2025 to middle February 2026: similar to Fig. 1, but showing the *two* batches of strips *used in parallel* to put in evidence batch differences; line simply joining subsequent data. Red symbols: *un-calibrated*; Blue symbols: *calibrated*. Triangle, large: @100: *time* of strip-batch change; @"105": batch with higher mean value indication. Period #730—#750: assumption of an inhibitor of proteomic pump.

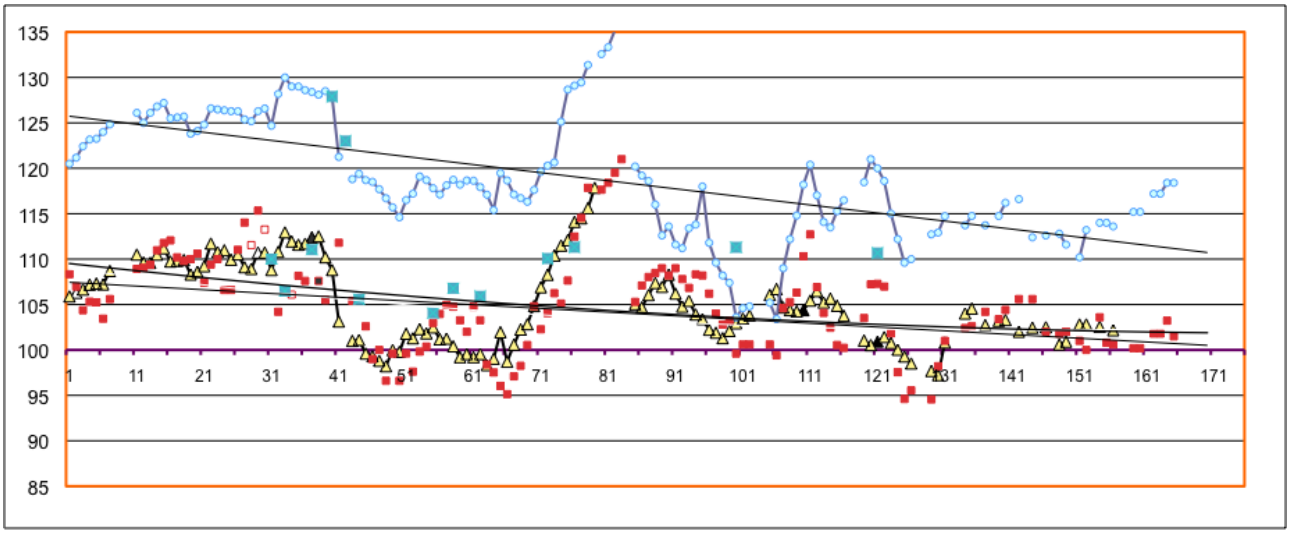


**Fig. 3.** Full period middle October 2025 to middle February 2026 of tests with no-metformin assumption: *each test is a subsequent dot*, even if performed *on the same day*.

Period #45—#65: assumption of an inhibitor of proteomic pump and start of use of a strip batch with lower indications by ≈10%. Tests #71—#81: holiday in other town with no diet. Tests around #95, #111 and #121: effect of diet irregularities at end-of-the-year holydays.

Blue line: *un-calibrated*; Red dots: *calibrated*, 10 days mean; Yellow triangles: *calibrated* 5 days mean. Square dots: *different calibrated* tester for comparison. Black triangle: Christmas, #111; End of 2025, #121.

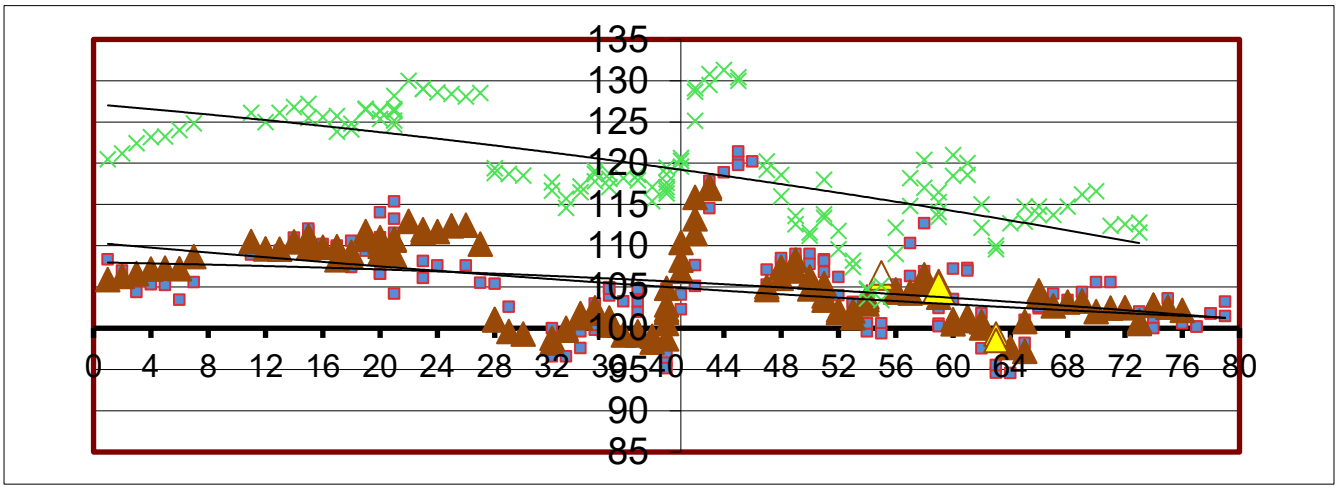


**Fig. 4.** No metformin: same period as in Fig. 3, but with tests on the *same day* indicated at the *same abscissa*. Period #28—#38: see period #45—#65 in Fig. 3. Period #41—#47: see period #71— #81 in Fig. 3. X: *uncalibrated indications*; Red triangles: *after (re)-calibration*, 5-days running *mean*; Square: *calibrated* 10-days running *mean* with another tester. Yellow triangles: Christmas #55 & Epiphany #63; #59 start of 2026.

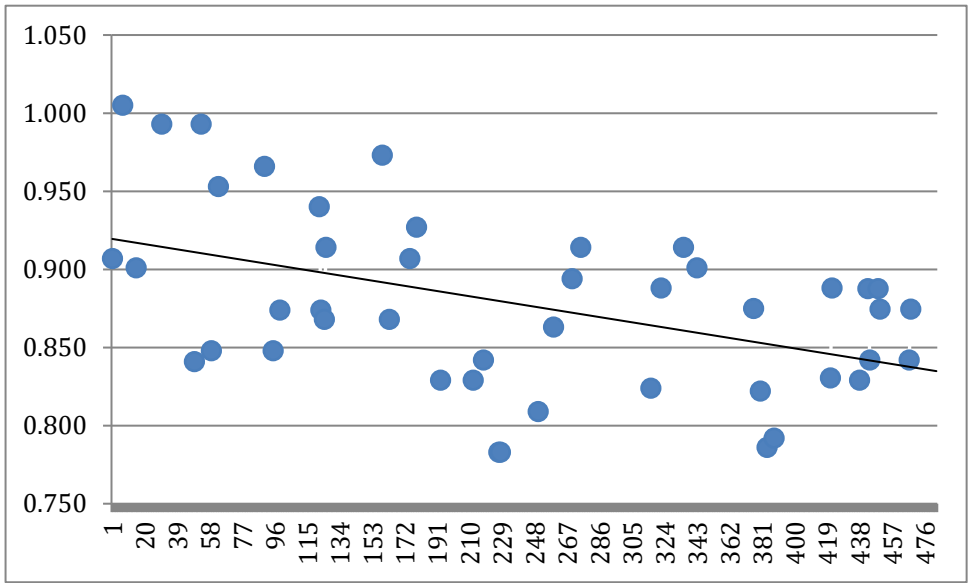


**Fig.5.** Tester calibration correction: period October 2025-February 2026. Mean 0.878; s.d. 5.6%.

## 4. Discussion

It seems difficult to attribute the present effect of metformin to a mere potential functional recovery of the pancreas, after a pancreatic insult, considering the 8-year period of metformin daily assumption (Fig.1 in Ref. 1): its effect was also occasionally reducing glucose concentration below the level of 100 mg/dL.

The same was occasionally found now (see also Fig. 1 here):

- Until *test #560* daily assumption of initial type of metformin: a periodic oscillation-like of glucose concentration is shown, also with some under-passings of the lowest pre-diabetic level 101 mg/dL.
- From *test #560* preliminary checks of second type of metformin assumption effect after short-period of *no*-metformin at all, repeated on 600: again, periodical (corrected) concentration values shown also < 100 mg/dL—as low as ≈80 mg/dL.

From test #610 until #730 *no-assumption* of metformin (nor other drugs *at all*) occurred again, then a second type of metformin assumption occurred until #760, then it again was suspended from #785, then again assumption of second type of metformin for a few days occurred and finally no-metformin was assumed anymore.

The lack of assumption of metformin, after an initial small glucose level increase as an expected effect of no-metformin assumption (about a week, already previously observed), the glucose level remained stable at the previous level—in the range 110-115 mg/dL (i.e. safely

within the 125 mg/dL limit), according to the usual author's statistics and with the standard deviation (s.d.) of the dispersion already normally observed for the (corrected) home-values.

Noticeable also that without metformin assumption some test values were even lower than 100mg/dL: the rare occurrence excludes a real lowering of glucose concentration to the no-disease region, being only an effect of test strip reproducibility.

Basically, *there is no present trend indicating a possible future increase of glucose concentration in blood*—if the rest of the normal life of the patient will remain identical. This situation can *occasionally* be modified by deviation from the normal patient life (restaurant dinners, more physical exercise, short periods of other diseases with assumption of other drugs, peculiar anomalies in current strip batches—already (rarely) observed in the past). It is instead not possible to envisage the *long-term* patient health, requiring the need of maintaining reliable statistics about glucose level in blood as done in [1–6].

In Table 1 a comparison is reported of the mean values of annual glucose concentration in blood for the period 2018-2025, as measured at home by the author or professionally in hospital: the difference looks compatible with the combined precision (s.d. not better than ± 5 mg/dL for the home measurements). In Table 2, the professionally measured values of glycated hemoglobin are reported since 2016 (year of the start of the disease). From 2018, i.e. ≈2 years after the start of metformin assumption, the mean value is 46 mmol/mol, so below the limit for pre-diabetes, to be compared with the range of the home-measured glucose concentration indicated above (110-115 mg/dL).

**Table 2.** Glycated hemoglobin (author) levels from hospital professional tests since pre-diabetes beginning of the disease. (upper "normal" limit, 48 mmol/mol, i.e. 6.5%; mean value from 2018: 46 mg/dL,)

| Date | *Glycated* | Date | *Glycated* |
|---|---|---|---|
| jun-2016 | *49* | dec-20 | 44 |
| jul-17 | *55* | mar-21 | 46 |
| jul-18 | 44 | jun-21 | 46 |
| oct-18 | 46 | jul-22 | 46 |
| mar-19 | 48 | jan-23 | *52* |
| ott-19 | 44 | oct-25 | 46 |
| aug-20 | 43 | jan-2026 | *47* |

The present case, examined by the author according to his long professional scientific experience in sound metrological measurements, showed evidence of the possibility to avoid any type of further drug prescription to ensure the stability of a pre-diabetic glycaemia condition, and within a safe small range of variations (s.d. 5% at 95% of confidence). The only author's prescribed-conditions suggested are: (1) to perform for a period of 2-3 months home checks according to the *full procedure* established here by the author, namely: (a) a frequent re-calibration of the home measuring apparatuses (**essential**); b) performing tests not later than 1 hour after getting up in the morning and before *any* fasting, liquids included except water; (c) performing double checks every time an anomalous value is obtained, possible using a second batch of strips kept available for these occurrences, also calibrated and found reliable—these conditions should guarantee a measurement reproducibility *not larger than 5%*; (2) to repeat the no-metformin procedure every year.

In particular, the patient should discard the tester, typically after 1-2 years of frequent use, if measured values increasing in time would occur also after its frequent recalibration, or if the tester's correction exceeds 15%.

Obviously, the method considered the most effective in medicine, the hospital measurement of *glycated hemoglobin* a few times per year (1 to 4), remains the preferred one (Table 2), but *home* tests allow *millions* of patients a short-term control and a sound *statistic*, so allowing them a stricter control of their life habit, useful to promptly decrease the risk of getting full diabetes.

The test requirements indicated above for the home tests are certainly quite demanding for several patients, but they do *not* involve assuming drugs, being simple *physical* operations only demanding some practice and attention—a few already partially pointed out in the present instruction leaflets provided by the apparatus manufacturers. The latter, however, should be much *more detailed about a standard procedure* namely, about the need for *home recalibration*—similarly, the relevant International Standards. [5] In fact, the step to the need for insulin is indeed an extremely *big change in the subsequent full life* of the patients.

Incidentally, the above considerations make quite more difficult to achieve the possibility of avoiding *the measurement via the use of a drop of blood*, by using devices presently under development for continuous glucose test, at least as the pre-diabetic range is concerned, due to the higher accuracy needed.

## 5. Conclusions

The results of the study on this case are expected to allow for a forecast over the longer term without need to get a statistics longer than a few months, highlighting two main issues: when combined with a healthy lifestyle, metformin can even help patients maintain a stable blood glucose level below 100 mg/dL in the medium to long term; additionally, the administration of metformin was not

necessarily needed to avoid an increase in blood glucose levels above 125 mg/dL over time.

Obviously, the author cannot assess that such a situation could be valid for any other patient, where medical assistance only can help in that respect. In addition, not being a medical doctor, the author cannot provide a *general* statement about the *lack of need* for the metformin administration. However, the results obtained by the author brings evidence of a need that could be useful to doctors, to avoid *automatically* prescribing metformin to pre-diabetic patients, by possibly performing an initial study of this case about the real needs. [1–6] The author also found in his case that the recently assumed metformin type immediately brought his glucose level *even below* 100 mg/dL, which can at least be considered a safer situation—this was also rarely observed with the initial type of metformin (see Fig.1 in [1]). On the other hand, this feature may also indicate that a correct diet and correct personal training can be sufficient by themselves to even avoid pre-diabetes.

On the other hand, medical doctors *should be advised to not pre-assume that the present normal immediate administration of metformin is needed and be valid for the 100% of the patients*, unless initial checks are performed to understand if metformin administration is really needed *in each specific case*, and then repeat it *periodically* whether its use will remain necessary in the subsequent years. Similarly, a *few* surpassing of the limit value of 125 mg/dL should *not* be considered sufficient to declare the patient full diabetic, without a *reliable statistics* becoming available.

## Disclaimer

The author is certainly not the first in author+patient conduction and description of a medical case publication. However, in this case, his specific professional expertise in measurement science (metrology) makes a better and reliable quality of the results of experimental work conducted on himself as a also the patient, though not pretending then to be typical nor valid in general, as explicitly indicated. Therefore, no ethical issues related to the coincidence of the patient with the expert performing the scientific tests and analysing the results can be considered biasing the report.

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[a] The concept of "evidence", today preferred to "experience" in medicine, is generally ignored in metrology, where correctness of assumptions must be *verified* from the results of measurements, as the highest possible level available to check their "truth".

[c] It was more or less the same for all trip batches and testers, the indication being higher than the correct glucose level except very few exceptions, and typically around ≈ +10 mg/dL— this paper considers *only capillary (full) blood*: when considered, plasma is always specified and converted to capillary blood.