Should Package Leaflets be Coloured in the Future?*)

Readability Test Results from the PAINT3 Study

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ABSTRACT

The use of colour to emphasise important information and headings of package leaflets has been recommended in the readability guideline of the European Union since 1998. The study referred to in this article investigated the advantages and disadvantages of coloured and black/greyscale versions. Package leaflets, created for three different medicines each using two templates of different lengths (a 200-word template and the QRD template), were printed once in colour and once in black font with greyscale illustrations. Using the written readability test, 192 participants located the information and answered 25 content questions over a timescale of 20 minutes (calculated median). The only significant advantage uncovered for either design option occurred in the case of coloured versions using the 200-word template, with participants causing less errors (12.1 % not found or incorrect answer) than in the black/greyscale versions (18.7 %). Patients tended to require less time to locate information when using only black font on white background; however, this was not significant. Therefore, both design options – coloured and black/greyscale – are appropriate for package leaflets.

ZUSAMMENFASSUNG

Sollten Packungsbeilagen zukünftig farbig sein? – Lesbarkeitstest-Ergebnisse der PAINT3-Studie

Der Gebrauch von Farben zum Hervorheben von Überschriften und wichtigen Informationen in Packungsbeilagen wird in der Readability Guideline der Europäischen Union seit 1998 empfohlen. Die nachfolgende Studie untersuchte die Vor- und Nachteile farbiger und schwarz/grau skalierter Versionen. Die Packungsbeilagen von 3 unterschiedlichen Arzneimitteln wurden unter Gebrauch von je 2 verschieden langen Templates (ein 200-Wörter-Template und das QRD-Template) einmal farbig und einmal schwarz/grau skaliert gedruckt. Im schriftlichen Lesbarkeitstest fanden 192 Teilnehmer die Informationen und beantworteten 25 Inhaltsfragen über einen Zeitraum von 20 Minuten (berechneter Median). Signifikante Vorteile beider Gestaltungsmöglichkeiten gab es nur bei farbigen Versionen mit dem 200-Wörter-Template, in dem signifikant weniger Fehler (12,1 % nicht gefundene oder falsche Antworten) als bei schwarz/grau-skalierten Versionen (18,7 %) auftraten. Dagegen benötigten die Teilnehmer bei schwarz/grau-skalierten Versionen weniger Zeit, die Inhalte zu finden. Jedoch war dies nicht signifikant. Daher sind beide Gestaltungsoptionen – farbig und schwarz/grau skaliert – für Packungsbeilagen geeignet.

KEY WORDS

- package leaflet
- coloured patient information
- readability test
- package insert test
- QRD template

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1. Introduction

For decades, package leaflets have been in regular use to communicate risks and the safe use of medicines in the European Union [1–4] – given that they must be delivered to patients in direct conjunction with medicines, in accordance with Article 58 of Directive 2001/83/EC. Regarding its content, *"the package leaflet shall be drawn up in accordance with the summary of the product characteristics"* with information being ordered as stated in Article 59(1) of this directive. Articles 59(3) and 63(2) instruct that the package leaflet must be legible, clear, understandable and easy to use for patients, albeit without providing any definition of what this means [5].

However, Articles 59(3) and 61(1) state that package leaflets require readability testing in cooperation with patients, while Article 65 refers to more detailed guidelines such as those concerning *"the legibility of particulars on the labelling and package leaflet"* – also known as the readability guideline [5].

In relation to colouration of package leaflets, since 1998, the readability guideline emphasises that colour

*) The study of coloured and black/greyscale package leaflets showed that coloured versions can improve this important patient information. However, careful consideration of their advantages and disadvantages suggests that both design options are appropriate for creating package leaflets.

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may help to highlight important information or headings. This supports patients in navigating through texts, whereby the *"same level headings should appear consistently (numbering, bulleting, colour, indentation, font and size) to aid the reader."* [6, 7].

To this end, chapter 1, section A of the readability guideline denotes that the colour selection for the paper and font should be considered in relation to the important contrast between the text and its background. As a general rule, dark text should be applied to a light background. Reversed type could be considered in exceptional cases to highlight warnings, for example; however, this may require larger font sizes or bold text [7]. In a study with 280 students, Paterson and Tinker found a 10.5 % quicker reading speed when using black font on white background in comparison to white font on black background, since words printed in black on white can be perceived at a greater distance than words printed in white on black [8].

According to the labelling section of the readability guideline, the number of colours used has to be carefully considered as too many colours can confuse [7]. The use of similar font colours in the same text, such as blue, green and purple, or the combination of red and pink is also not recommended [9, 10].

Using similar colours for text and background also impairs the legibility; therefore, this should be avoided [7]. Tinker and Paterson investigated the reading speed for 10 combinations of font and background colours, dividing 850 college students into 10 equal groups. Black font on white background was the most quickly legible combination; green and blue font on a white background and black font on a yellow background were almost as good. Combinations of orange on black or white background, red on green and black on purple were difficult to read [11]. Both authors also investigated eye movements of 20 students and found that in comparison to red font on green, the use of black font on white background has:

- 24.8 % lower number of eye fixations,
- 20.2 % more words can be read per eye fixation,
- 14.5 % lower pause-duration between eye fixations,
- 42.6 % lower perceptual time [12].

This means, reading speed is faster since more words can be perceived in less time.

The readability guideline recommendations relating to colouration of package leaflets are in line with the German norm DIN 1450 Lettering – Legibility, which also raises the issue of colour vision deficiency. If colours are used to emphasise words or text elements, people with reduced red-green sensitivity or blindness, for example, have decreased ability to see colour or differences in colour [13]. Worldwide, about 8 % of all men (6–10 % European, American and Australian Whites; 2–9 % Asians; 1–2 % American Indians, Africans, Australian aborigines) and 0.4 % of all women do not have a normal sense of colour [10, 14, 15]. For these people, other types of emphasis are advisable such as bold print or larger font size [13].

Of the two colours most frequently used in package leaflets – black and blue (e.g. 69.8 % of German package leaflets available in 2005 used only black font and 11.6 % only blue font) –, black showed, with on average 15.0:1, significantly higher contrast to the used background compared to blue, with 9.5:1 [16]. Other colours used in the 258 investigated randomly selected package leaflets were green (0.4 %) and purple (0.4 %), while the remaining package leaflets used more than one font colour (11.2 % black text/once medicine name in white font in black bar at the beginning, 1.9 % black text/green headings or other accentuations, 1.6 % blue text/once medicine or company name or others in white font in blue bar, 1.2 % black text/blue headings or other accentuations, 1.2 % black text/red headings or other accentuations, 0.4 % blue text/green headings, 0.4 % black text/white and blue headings/red and green accentuations).

The attributes of black font on white background – the highest contrast and best reading properties – were certainly in the thoughts of the Brazilian authorities when they recommended in 2009 that the content of package leaflets should be printed in black on white paper [17].

The literature search of the PIL-S study on behalf of the European Commission included 20 studies that concerned the layout/design of package leaflets (PIL). *"Many studies gave recommendations for improvement of the PIL. These included: a preference for a more detailed but schematic PIL without use of colours."* However, in the same chapter of the PIL-S study report, with reference to previous literature reviews, the use of colour is recommended to improve the readability and appeal of written medical information, in two of the three cited previous reviews. In the stakeholder survey of the PIL-S study, 47.7 % of 65 representatives of patient and consumer organisations and 27.9 % of 86 pharmaceutical industry representatives preferred the use of different text colours to highlight important information in the package leaflet. That said, both groups provided a higher preference for the use of different font types, text boxes and a larger font size in this context. On the other hand, 4 of 5 readability testers involved favoured the use of different colour [18].

Thus, the question arises whether and, if so, which advantages of text colouration in package leaflets exist for patients; particularly given the higher print costs and more complex design processes involved for pharmaceutical companies in comparison to the black/greyscale alternative.

2. Material and Methods

Package leaflets of three frequently used medicines – repaglinide, enalapril, insulin – were optimised using a set of 152 quality criteria [19]

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Gebrauchsinformation:
Information für den Anwender

Insu 50/50 Patronen
100 Einheiten pro ml

Insulin

Lesen Sie die gesamte Packungsbeilage sorgfältig durch, bevor Sie mit der Einnahme dieses Arzneimittels beginnen.
- Heben Sie die Packungsbeilage auf. Vielleicht möchten Sie diese später nochmals lesen.
- Wenn Sie weitere Fragen haben, wenden Sie sich an Ihren Arzt oder Apotheker.
- Dieses Arzneimittel wurde Ihnen persönlich verschrieben. Geben Sie es nicht an Dritte weiter. Es kann anderen Menschen schaden, auch wenn diese die gleichen Beschwerden haben wie Sie.
- Wenn eine der aufgeführten Nebenwirkungen Sie erheblich beeinträchtigt oder Sie Nebenwirkungen bemerken, die nicht in dieser Gebrauchsinformation angegeben sind, informieren Sie bitte Ihren Arzt oder Apotheker.

Diese Packungsbeilage beinhaltet:
1. Was ist Insu und wofür wird es angewendet?
2. Was müssen Sie vor der Anwendung von Insu beachten?
3. Wie ist Insu anzuwenden?
4. Welche Nebenwirkungen sind möglich?
5. Wie ist Insu aufzubewahren?
6. Weitere Informationen

1. Was ist Insu und wofür wird es angewendet?
- zur **Senkung des Blutzuckers** bei Diabetes

2. Was müssen Sie vor Anwendung von Insu beachten?
Insu darf nicht angewendet werden,
- wenn Sie überempfindlich (allergisch) gegen Insulin oder einen der sonstigen Bestandteile von Insu sind
- bei Unterzuckerung

Besondere Vorsicht bei der Anwendung von Insu ist erforderlich
- wenn Sie verengte Blutgefäße haben, die Herz oder Gehirn versorgen
- wenn Sie einen verändertem Augenhintergrund haben
- wenn Sie Leber- oder Nierenbeschwerden haben
- wenn Sie über 65 Jahre alt sind

In diesen vier Fällen sollten Sie vor der Anwendung von Insu Ihren Arzt informieren..

Bei Anwendung von Insu mit anderen Arzneimitteln
Bitte informieren Sie Ihren Arzt oder Apotheker, wenn Sie andere Arzneimittel anwenden bzw. vor kurzem angewendet haben, auch wenn es sich um nicht verschreibungspflichtige Arzneimittel handelt.
- Antibiotika, wie Sulfamethoxazol
- Cholesterinsenker, deren Wirkstoffname auf –fibrat endet
- Clonidin, Guanethidin, Reserpin: Mittel gegen Bluthochdruck
- Cortison
- Danazol: ein Mittel gegen Wucherungen der Schleimhaut der Gebärmutter
- Diazoxid, Glukagon: zuckersteigernde Mittel
- Disopyramid: ein Mittel gegen Herzrhythmusstörung
- Epinephrin: ein Mittel gegen Bluthochdruck oder bestimmte Schocksituationen
- Fluoxetin, Moclobemid, Tranylcypramin, Lithium: Mittel gegen Depressionen
- Isoniazid: ein Mittel gegen Tuberkulose
- harntreibende Mittel
- Herz- und Kreislaufmittel, deren Wirkstoffname auf –olol oder –pril endet
- Mittel gegen geistige Störungen oder Übelkeit deren Wirkstoffname meist auf –azin endet
- Mittel gegen Zuckerkrankheit
- Pentamidin: ein Mittel gegen Parasiten
- Pentoxifyllin: ein Mittel zur Durchblutung
- Propoxyphen: ein Mittel gegen Heroinsucht
- Salbutamol, Terbutalin: Mittel zur Erweiterung der Lungenatemwege
- Schmerzmittel, wie Acetylsalicylsäure
- Schilddrüsenhormone
- Somatropin: ein Wachstumshormon
- weibliche Sexualhormone

Bei Anwendung von Insu zusammen mit Nahrungsmitteln und Getränken
Verzichten Sie bitte auf Alkohol.

Schwangerschaft und Stillzeit
Verwenden Sie Insu nur wenn es der Arzt für unbedingt notwendig einschätzt, wenn Sie schwanger sind oder stillen.

Fragen Sie vor der Einnahme von allen Arzneimitteln Ihren Arzt oder Apotheker um Rat.

Verkehrstüchtigkeit und Maschinen
Bedienen Sie Fahrzeuge oder Maschinen erst nach Erlaubnis Ihres Arztes.
Schwankungen des Blutzuckers können Ihr Reaktionsvermögen beeinträchtigen.

Wichtige Informationen über bestimmte sonstige Bestandteile von Insu
Dieses Arzneimittel enthält weniger als 1 mmol Natrium (23 mg) pro Dosis.

3. Wie ist Insu anzuwenden?
Wenden Sie Insu immer genau nach Anweisung des Arztes an. Bitte fragen Sie bei Ihrem Arzt oder Apotheker nach, wenn Sie sich nicht ganz sicher sind.

Spritzen Sie Insu **immer nach Anweisung Ihres Arztes.** Er bestimmt die Häufigkeit der Anwendung, Einzel- und Tageshöchstdosis.
- maximal so viel spritzen, dass Ihr Blutzucker immer über 2,8 mmol / l oder 50 mg / dl ist

Informieren Sie den Arzt bei:
- Problemen der Anwendung oder Einstellung des Blutzuckers
- Änderung des Tagesablaufs oder Reisen
- Wechsel körperlicher Aktivität oder Ernährung
- Krankheiten, Verletzungen

Art der Anwendung
- 20 bis 30 Minuten vor einer Mahlzeit spritzen – meist früh und abends
- Patrone in Optipen einsetzen, wie vom Arzt oder Apotheker erklärt
- vor jedem Gebrauch mischen durch 10-mal langsames Kippen des fertigen Optipen
- Luft entfernen, Menge einstellen, Hautfalte bilden, unter Haut stechen, applizieren
- **nicht in Venen spritzen**, Spritzstelle vor jeder neuen Anwendung wechseln
- nicht mit anderen Flüssigkeiten mischen und nicht für Insulinpumpen gebrauchen
- im Notfall Spritzen mit 100 Einheiten/ ml nutzen

Dauer der Anwendung
- bestimmt Ihr Arzt

Lesen Sie bitte aufmerksam die Packungsbeilage!

Enal 20 mg Tabletten

1. Wofür wird Enal verwendet?
- gegen hohen Blutdruck
- gegen verringerte Herzleistung kombiniert mit anderen Mitteln
- Fehlfunktion der linken Herzkammer

2. Was müssen Sie vor Einnahme von Enal beachten?
Nicht einnehmen bei
- Überempfindlichkeit gegen einen Bestandteil von Enal
- Schwangerschaft
- Stillzeit
- Kindern unter 18 Jahre
- gestörte Leberfunktion
- Therapie zur Abschwächung einer Allergie gegenüber Insektengiften
- Ausflussbehinderung der linken Herzkammer
- Neigung zu meist schmerzhafter, starker Schwellung tiefer Hautgewebe, oft im Gesicht
- Verengung von Blutgefäßen der Niere
- nach Transplantation einer Niere
- zu viel des Hormons Aldosteron im Blut
- Gebrauch spezieller Membranen zur Dialyse wie AN 69®
- Entfernen von LDL-Cholesterin mit Dextransulfat

Erst nach Arztrücksprache einnehmen bei
- gestörter Nierenfunktion
- Eiweiß im Urin über 1 g pro Tag
- gestörtem Mineralhaushalt
- Dialyse – Siehe auch: „Nicht einnehmen bei"
- gestörter körpereigener Abwehr
- dauerhafter Verhärtung von Hautbereichen
- Mangeldurchblutung im Herz oder Gehirn

Einnahme mit anderen Arzneimitteln
Reden Sie mit Ihrem Arzt oder Apotheker bei Gebrauch anderer Arzneimittel in den letzten 14 Tagen. Dies gilt besonders bei:
- Allopurinol: ein Mittel gegen zu viel Harnsäure
- Blutzucker senkende Mittel
- Blutdruck senkende Mittel
- chemische Schlafmittel
- Cortison zum Verabreichen in den Körper
- die körpereigene Abwehr senkende Mittel
- harntreibende Mittel, die Kalium im Körper zurückhalten
- Heparin: ein Mittel zur Blutverdünnung
- Lithium: ein Mittel gegen seelische Störungen
- kaliumhaltige Mittel
- Mittel zur Betäubung
- Mittel gegen Krebs.
- Mittel gegen Schmerzen, Entzündungen oder Fieber, wie Acetylsalicylsäure, Indometacin
- Procainamid: ein Herzmittel

Nahrungsmittel und Getränke
Verzichten Sie auf das Rauchen, Alkohol und den Verzehr von mehr als 6 g Salz pro Tag.

Verkehrstüchtigkeit und Maschinen
Bedienen Sie Fahrzeuge oder Maschinen erst nach Rücksprache mit Ihrem Arzt.
Eine Therapie mit Enal kann Ihr Reaktionsvermögen beeinträchtigen.

3. Wie ist Enal einzunehmen?
Nehmen Sie Enal immer nach Anweisung Ihres Arztes ein.

Hoher Blutdruck
- Startdosis: ½ Tablette täglich
- **Übliche Dosis: 1 Tablette täglich**
- Maximale Tagesdosis: 2 mal 1 Tablette

Andere Anwendungsgebiete
- Nur für die Startdosis schwächere Tabletten nutzen!
- **Übliche Dosis: ¼ Tablette täglich**
- Maximale Tagesdosis: 1 Tablette

Nierenkranke und über 65-Jährige
- Startdosis: ist von der Nierenfunktion abhängig
- Maximale Tagesdosis: 1 Tablette

Art der Einnahme
- unabhängig von den Mahlzeiten und immer zur selben Tageszeit, bevorzugt morgens
- sitzend oder stehend mit einem Glas Wasser mit mindestens 100 ml Inhalt
- teilen der Tabletten wie im Bild zu sehen

Dauer der Einnahme
- bestimmt Ihr Arzt

Figure 1: Examples of coloured and corresponding black/greyscale package leaflets tested (Both Enal-versions use the short 200-word model template and the Insu-versions the QRD template 1.2 (valid at the time of the study; Source: All figures were made by the authors/PAINT-Consult.).

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and printed in colour on light yellow paper and in black font with greyscale illustration on white paper using:

a) the QRD template for MR and DC procedures, version 1.2 [20]
b) a model template based on the QRD template, but optimised to contain less than 200 words, mainly through avoiding repetitions and long sentences [21]

All six pairs were identical in wording and design – in two-column portrait format as it is the mostly used format within the European Union [22, 23], and minimum 9pt font size. The only difference was the use of colour instead of only black font with greyscale illustration on white background (fig. 1). Red colour was used for headings in the coloured package leaflets of enalapril and repaglinide, while blue was used for the insulin leaflet as an alternative option – red and blue differ well from black [10].

Between September 2008 and May 2009, the package leaflets were investigated using the written readability test – also known as "self-completion method" – as it is accepted within the European Union and avoids the external negative influences which may occur in the Australian face-to-face interview [24]. The questionnaire from the PAINT1 study was used (one per medicine), in which the number of questions relating to the package leaflets' key contents was increased from 15 to 25, with 18 statements concerning participants' opinions of the package leaflets to extract more data [25].

The participants were recruited in various public facilities – such as community centres – in Jena and Weimar and their surroundings areas (Germany). Under the supervision of a tester, each participant tested just one package leaflet, using only the written instructions provided in the questionnaire. In accordance with predefined criteria, a minimum of 15 people was recruited per package leaflet version, with healthcare professionals excluded.

All data retrieved was coded and inserted into a SPSS 16.0 statistic program table via double data input for checking. Percentages of information not found and incorrectly comprehended as well as medians of the time required to locate the 25 key messages were calculated per package leaflet.

The five point scale listed under Tables 2a and 2b was used to calculate medians for each of the 18 participants' assessments relating to the package leaflets' comprehensibility, legibility, complexity of information, clarity and structure as well as their trust in the relevant medicine.

3. Results

A total of 192 people between the age of 11 and 79 years participated, with an average age of 34 years. Half of the participants were female (52.1 %), 91.1 % spoke German as first language and 41.1 % used one or more medicines daily. They read for 1 to 2 hours daily and heard, saw or read 1 medical report weekly (medians). The education levels were: 8th class 12.4 %, 10th class 32.3 %, A-level 40.3 %, technical college 9.1 % and university 5.9 %. The daily use of medicines was: none 58.9 %, 1 medicine 21.9 %, 2 medicines 9.4 %, 3–4 medicines 7.3 %, 5–7 medicines 2.1 % and 8–10 medicines 0.5 %. Of the 79 participants who regularly used medicines, 10 used a product with a similar indication to the one described in their tested package leaflet.

There were no significant differences between the group who tested a coloured package leaflet compared to the group testing a black/greyscale version (age: Mann-Whitney U test; remaining demographic data: Pearson's chi-square test), the only exception being the gender distribution. In the group that tested coloured package leaflets, 61.9 % were female in comparison to 42.6 % in the group testing a black/greyscale version ($p = 0.008$).

It took between 5 and 75 minutes (calculated median: 20 minutes) for participants to locate the 25 requested contents and to write their answers. Table 1 shows that 10.3 % more time was required when using the coloured versions, but this was not significantly different to the black/greyscale versions. Using a black/greyscale version resulted in more "not found" or "incorrect" answers compared to coloured package leaflets. However, no difference between both groups showed significance in the Mann-Whitney U test – even after summarising "not found" and "incorrect' answers (Table 1).

Participants' opinions relating to the package leaflets were positive and comparable in both template groups (Tables 2a and 2b). No significant differences in participants' assessments were found between the coloured package leaflets group and the black/greyscale versions for each of the 18 opinions explored (e.g. motivation to read the package leaflet and legibility); nor after summarising the 18 statements (Pearson's chi-square test).

The sub-analyses of all package leaflets using the 200-word model template showed only one significant result. The cohort using a colour version caused significantly fewer errors than the one using a black/greyscale version (average of "not found" or "incorrect" answers in coloured package leaflets of 12.1 % versus 18.7 % in black/greyscale versions; $p = 0.010$; Mann-Whitney U test). No significant differences occurred between the coloured and black/greyscale package leaflets in those cohorts using the QRD template. This applied also to the average of "not found" or "incorrect answers" in versions using the QRD template (coloured versions: 18.5 %; black/greyscale: 17.1 %).

4. Discussion

4.1 What are the Advantages of Coloured Package Leaflets?

The use of different colours in headings can improve navigation through the text, resulting in slightly less not found or misunderstood information in coloured package leaflets of this study. However, this was only significant in the group of package leaflets using the 200-word model template (Tables 2a and 2b). The use of colour to emphasise headings might be helpful for a clearer separation of different information sections. Nevertheless, use of bold print and/or larger font sizes is also appropriate [7, 13].

There are no limitations of the study results presented in chapter 3 expected due to the test method, as the written readability test method is officially accepted by all EU member states. In particular, this method avoids external influences, such as caused by mimicking, gestures and hearing problems, thereby guaranteeing

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■ **Table 1**

Comparison of package leaflets using coloured design with those using a black/greyscale design, in the time required to locate information, percentages of not located contents, and misunderstood information, itemised per package leaflet.

Package leaflet	Percentage of "not found" answers relating to the 25 content questions (average in %)		Percentage of "incorrect" answers of the located information (average in %)		Percentage of "not found" and "incorrect" answers relating to the 25 content questions (average in %)*		Time needed to locate the 25 pieces of tested information (calculated medians in min)		Number of participants		Number of words per package leaflet
	coloured	black/white	coloured	black/white	coloured	black/white	coloured	black/white	coloured	black/white	
Enalapril with 200-word template	3.2	9.3	6.6	10.7	9.3	18.3	18.5	16.7	16	16	849
Insulin with 200-word template	7.3	7.7	10.2	16.4	16.1	21.9	25.0	17.8	17	15	835
Repaglinide with 200-word template	4.2	7.2	7.0	9.3	10.9	15.9	15.4	19.4	17	16	682
Enalapril with QRD template	9.7	8.2	12.7	12.4	19.2	18.3	25.0	20.0	16	16	1,333
Insulin with QRD template	8.2	7.4	14.9	15.4	20.5	21.4	25.0	21.2	16	16	1,265
Repaglinide with QRD template	3.2	3.0	13.4	9.0	15.9	11.5	20.0	22.0	15	16	1,093
Average	6.0	7.1	10.8	12.2	15.3	17.9	21.5	19.5	–	–	–

* "Percentage of 'not found' and 'incorrect' answers relating to the 25 content questions" is the summary of the second and third column ("not found" and "incorrect" understood information).

identical study conditions for each participant – an essential requirement for comparing both leaflet versions [24]. Also, any influence on the results due to the significant difference in gender distribution in both investigated package leaflet groups is unlikely, as the PAINT1 readability test study with 1,105 participants showed no significant gender specific differences in the fractions of "correct", "incorrect" and answers "not found", nor in the corresponding time required [25].

However, a cross-over study design wherein the coloured and its corresponding black/greyscale version are tested by the same participant, as used in the PAINT1 study, could have an advantage [25, 27]. Furthermore, a higher number of participants could provide more significant differences between coloured and black/greyscale package leaflets. Influences on the results caused by non-participation of those with reading and writing difficulties are also unlikely, as identical test conditions applied to both coloured and black/greyscale versions. Moreover, a minimum reading level is the basic requirement for using package leaflets independent of the used test method.

Based on the authors' research [26] and readability test experiences, major variations of the results are also not anticipated when using other languages. However, using different layout/design and/or more extensive package leaflets could lead to other results.

4.2 Would Patients Prefer Coloured Package Leaflets?

It is important to discuss the result of coloured package leaflets not inducing higher motivation to read the provided content. Moreover, coloured package leaflets do not increase patients' desire to purchase the medicine described in the package leaflet in comparison to black/greyscale leaflets of medicines with the same active substance. Based on the results of Tables 2a and 2b, this clearly shows that package leaflets are not suitable as a sales-promoting marketing instrument or for advertising purposes – not even very short package leaflets. This finding contradicts similar research and published marketing opinions for product groups other than medicines [28].

In addition, there was no increased preference for coloured package leaflets instead of black/greyscale versions in the future.

In an opinion survey with 1,004 participants conducted in Italy in 1997, Bernardini et al. found that 65.7 % of respondents did not want coloured package leaflets. This aversion increased with a decrease in the

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Table 2a

Participants opinions, itemised per package leaflet (selected opinions and summary of all 18 statements).

Package leaflet	The first impression of this package leaflet motivated me to read further. (calculated median)		The information requested in the 25 content questions was easy to find. (calculated median)		The contrast between the colour of the letters and paper supports the legibility. (calculated median)		The text is easy for me to read. (calculated median)	
	coloured	black/ white	coloured	black/ white	coloured	black/ white	coloured	black/ white
Enalapril with 200-word template	2.0	1.8	1.2	1.4	1.5	1.8	1.3	1.5
Insulin with 200-word template	2.1	2.0	1.7	1.5	1.5	1.5	1.4	1.1
Repaglinide with 200-word template	1.7	1.8	1.3	1.3	1.6	1.5	1.2	1.3
Enalapril with QRD template	1.8	2.4	1.6	1.6	1.3	1.6	1.2	1.2
Insulin with QRD template	2.1	2.2	1.7	1.9	1.6	1.4	1.3	1.4
Repaglinide with QRD template	1.7	1.8	1.6	1.4	1.6	1.9	1.5	1.1
Average	1.9	2.0	1.5	1.5	1.5	1.6	1.3	1.3

Code of participants' opinions: "yes" = 1, "mostly yes" = 2, "other" = 3, "mostly no" = 4, and "no" = 5, whereby "yes" was the preferred answer.

level of education. One explanation by the authors suggested that people associate colour with other commercial products and believe that the scientific character of the serious message presented in package leaflets is diminished, becoming tantamount to everyday advertising of a commercial product [29]. Another issue is that colours can emphatically convey information and emotions, as found by Hemphill after questioning of 20 female and male students each. Light colours (white, pink, red, yellow, blue, green and purple) were mainly associated with positive emotions and dark colours (brown, black and grey) with negative ones. Women responded positively to bright colours more often than men. Red was often associated with excitement [30].

4.3 What are the Disadvantages When Using Colour to Emphasise Texts?

Even if not significant, the shorter time required to find the 25 requested contents in package leaflets with black font only on white background can be explained by black on white having the highest contrast. Therefore, it can be read the fastest, as found by Tinker and Paterson [8, 11, 12].

Ekstrom found that adults from 45 years onwards require more contrast between font and background than younger people, with those aged over 70 requiring three times more contrast than 20-year-olds [9]. While a coloured package leaflet may do no harm, having sufficient contrast between font and background is essential.

As mentioned in the introduction, the problem of reduced colour sensitivity or colour blindness represents another very important issue when deciding to use colour for emphasising texts, as this affects a large section of the population [10, 14, 15].

4.4 Value of Coloured Package Leaflets in Comparison to Shorter Texts

Careful colour design can improve package leaflets, although this does not place black/greyscale versions in a generally inferior position. Moreover, results show that the benefit of coloured package leaflets is lower than would accrue when a significant reduction of the word count is implemented, as found in several studies [21, 26, 27]. The results shown in Tables 1a, 1b and 2 were already evaluated in the comparison of package leaflets using the QRD template versus the 200-word model template. Using the shorter model template results in less template texts per package leaflet – headings and standard text, but not medically-specific content. This text compression of as much as 400 to 500 words leads to a significant reduction of 18.1 % in time required to locate the 25 pieces of requested information, which was not found for coloured package leaflets. Furthermore, the comparison of both groups with different template length showed that participants locate and understand significantly more information when using the shorter 200-word template [21]. The greater influence of the volume of text can explain the fact that coloured package leaflets had a significant advantage in locating and

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■ **Table 2b**

Participants opinions, itemised per package leaflet (selected opinions and summary of all 18 statements).

	I feel well informed by the information contained in this package leaflet. (calculated median)		The content of this package leaflet does not raise my concerns about using this medicine. (calculated median)		Because of this package leaflet, would I prefer the medicine to other medicines with the same active ingredients? (calculated median)		Would you like all package leaflets to be similar to this one? (calculated median)		Summary of participants' opinions relating to the package leaflet (average of all 18 statements)*		Number of words per package leaflet
	coloured	black/ white	coloured	black/ white	coloured	black/ white	coloured	black/ white	coloured	black/ white	
Enalapril with 200-word template	1.8	1.5	3.2	3.2	3.0	3.2	2.4	1.9	2.0	2.0	849
Insulin with 200-word template	1.8	1.6	1.8	1.7	3.3	3.0	2.1	1.9	2.0	1.8	835
Repaglinide with 200-word template	1.4	1.8	2.4	2.3	2.4	2.7	1.6	2.2	1.7	2.0	682
Enalapril with QRD template	1.5	1.5	3.2	2.4	2.8	3.2	1.8	2.0	1.9	1.8	1,333
Insulin with QRD template	1.7	1.7	2.4	2.0	3.1	3.0	1.6	1.9	2.0	2.0	1,265
Repaglinide with QRD template	1.6	1.5	2.5	2.0	3.5	2.8	1.8	1.5	2.0	1.7	1,093
Average	1.6	1.6	2.6	2.3	3.0	3.0	1.9	1.9	1.9	1.9	–

Code of participants' opinions: "yes" = 1, "mostly yes" = 2, "other" = 3, "mostly no" = 4, and "no" = 5, whereby "yes" was the preferred answer.

understanding provided information only when using the shorter model template (average of "not found" or "incorrect" answers in coloured package leaflets of 12.1 % versus 18.7 % in black/greyscale versions). This advantage was not found for versions using the QRD template.

Participants tended to require less time to locate information when using package leaflets with only black font on white background. However, this difference was not significant. Therefore, both design options – coloured and black/greyscale – are appropriate for package leaflets.

The QRD template compression as outlined here has the potential of bringing significantly greater and quicker improvements to all package leaflets used in the European Union than would be achieved by the introduction of coloured versions. The proven benefit of this text reduction is without any loss of medical specific information and is known since January 2012 [21, 26]. In recent years, countless conferences have been held to improve package leaflets, expensive studies commissioned by authorities and politicians have been carried out (e.g. the PIL-S study with a budget of 174,576 Euro [18, 31]) or their declarations of intent have been published (e.g. the report from the Commission to the European Parliament and the Council dated March 2017 or the EMA action plan published November 2017 [32–34]). To this day, not one of them has elicited any fundamental change by the auspices of responsible authorities and politicians.

5. Conclusion

The use of colour in package leaflets can improve this important patient information. However, the reduced contrast and legibility of coloured texts compared to black font and problems for people with reduced colour sensitivity or colour blindness must be considered before using this option to emphasise texts. Given the provided results, no reason exists for a general favouritism for coloured package leaflets over their black/grey scale package equivalent.

Conflict of Interest

The authors have no conflict of interest to declare.

Furthermore, they confirm that all patient/personal identifiers have been removed or disguised. Thus, the patient/person(s) who participated in this study are not identifiable and cannot be identified through the provided details.

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Moreover, the authors confirm that the results have not been published before and that they hold all copyrights of the manuscript – text, figures and tables.

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