Pharmacology

Systematic Review

Pharmacology 2023;108:415–422
DOI: 10.1159/000533327

Received: March 18, 2023
Accepted: July 26, 2023
Published online: August 25, 2023

Propofol-Associated Urine Discoloration: Systematic Literature Review

Ana Lasica[a] Cinzia Cortesi[b, c] Gregorio P. Milani[d, e] Mario G. Bianchetti[a, c]
Federica M. Schera[a] Pietro Camozzi[f] Sebastiano A.G. Lava[g, h]

[a]Family Medicine, Faculty of Biomedical Sciences, Università della Svizzera Italiana, Lugano, Switzerland; [b]Pediatric Anesthesia, Institute of Pediatrics of Southern Switzerland, Ente Ospedaliero Cantonale, Bellinzona, Switzerland; [c]Faculty of Biomedical Sciences, Università della Svizzera Italiana, Lugano, Switzerland; [d]Pediatric Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy; [e]Department of Clinical Sciences and Community Health, Università degli Studi di Milano, Milan, Italy; [f]Department of Anesthesia, Hôpital du Valais, Sion, Switzerland; [g]Pediatric Cardiology Unit, Department of Pediatrics, Centre Hospitalier Universitaire Vaudois and University of Lausanne, Lausanne, Switzerland; [h]Clinical Pharmacology and Therapeutics Group, University College London, London, UK

Keywords
Propofol · Urine · Discoloration · Acute kidney injury · Anesthesia

Abstract

Introduction: Propofol occasionally induces a green or pink-cloudy urine discoloration. A lesser-known effect is green discoloration of hair, milk, liver, or stool. We aimed to gain insight into the features of these disturbances. ***Methods:*** The terms ("propofol" OR "fospropofol") AND ("green" OR "pink" OR "cloudy" OR "pink-cloudy") were searched in Excerpta Medica, MEDLINE/PubMed®, and Web of Sciences databases, with no language limit, from inception up to February 2023 (CRD4202236804). Articles reporting individually documented cases were retained, and data were extracted using a checklist. ***Results:*** Seventy-seven original reports documented 95 cases (including 13 subjects ≤18 years of age). Completeness of reporting was satisfactory in 33, good in 35, and excellent in 27 cases. Propofol-associated green urine discoloration was observed in 54 patients. In most instances ($n = 21$, 39%), propofol was given for ≥24 h. Sometimes, however, the urine discoloration developed after propofol for ≤3 h ($n = 12$, 22%). Propofol-associated urine discoloration was usually observed during the administration of this agent, but it was at times ($n = 11$) first recognized ≥3 h after propofol discontinuation. The duration of green urine discoloration was usually ≤24 h after stopping propofol. Propofol-associated green urine discoloration was never associated with worsening kidney function. A pink-cloudy urine discoloration was observed in 32 subjects with an acidic urine pH and increased uric acid excretion given propofol for ≤24 h. A stage I acute kidney injury was observed in 2 cases (6.3%) of propofol-associated pink-cloudy urine discoloration. Nine cases of non-urinary green discoloration were observed: hair ($n = 4$), breast milk ($n = 1$), liver ($n = 1$), stool ($n = 1$). ***Conclusion:*** Propofol is sometimes associated with a green (benign) or pink-cloudy (occasionally associated with mild acute kidney injury) urine discoloration. Rarely, non-urinary green discoloration has been reported.

Ana Lasica and Cinzia Cortesi contributed equally to this work and therefore share first authorship.

karger@karger.com
www.karger.com/pha

Correspondence to:
Sebastiano A.G. Lava, webmaster@sebastianolava.ch

Introduction

The intravenous phenol anesthetic agent propofol is very commonly used because of its rapid effect, short action, and relatively safe profile [1]. Induction and maintenance of general anesthesia as well as sedation during non-surgical interventions and critical care both in children and adults are the main indications.

Some case reports indicate that propofol occasionally induces a pronounced green or pink-cloudy discoloration of the urine [2, 3]. A lesser-known effect is green discoloration of hair, milk, liver, or stool. Since case reports have limitations that hinder a scientific approach, we undertook a systematic review of the literature on these topics. The aims of this work were to gain insight into the features of these uncommon adverse drug reactions, characterize their time pattern, address the potential harm to the kidneys, and give suggestions for management.

Methods

Data Sources and Searches

This review was preregistered in the International Prospective Register of Systematic Reviews (CRD4202236804) and undertaken in agreement with the 2020 edition of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, a set of items for reporting systematic reviews and meta-analyses [4]. We carried out a literature search in accordance with the Joanna-Briggs Institute Manual for Reviews [5] with no language and date limits using three databases: Excerpta Medica, MEDLINE/PubMed®, and Web of Science. The search terms were as follows: ("propofol" OR "fospropofol") AND ("green" OR "pink" OR "cloudy" OR "pink-cloudy"). Articles listed in Google Scholar, articles already known to the authors, and references listed within bibliographies were also considered for inclusion. The first searches were conducted in December 2021. Notifications for new search results were inspected monthly until submission.

Study Selection and Data Extraction

Eligible were original articles and letters reporting individually documented humans given intravenous propofol presenting an otherwise unexplained green or pink-cloudy urine discoloration. Cases with green discoloration of hair, liver, milk, or stool were also considered.

In a first selection round, two authors independently screened the results of the initial literature search based on titles and abstracts. In a second round, they independently assessed the full-text articles of the remaining studies. For each round, discrepancies were solved by consensus and, if needed, by consultation with two senior authors.

In addition to demographics, from each reported case, we extracted following data: duration of the propofol administration; characteristics and duration of the discoloration; the termination of propofol after onset of discoloration; the existence of a time interval of 3 h or more between discontinuation of propofol and onset of urine discoloration; and laboratory data. The term "urine bag discoloration phenomenon" was used when urine of normal color became a different color in the urine bag [6].

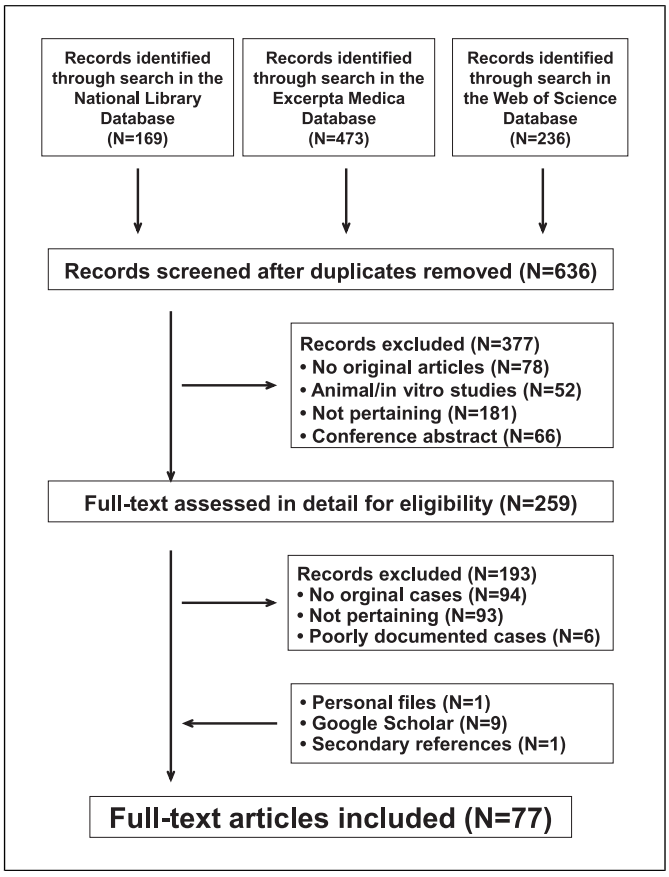

Fig. 1. Propofol and urine discoloration. Flowchart of the literature search process.

Other causes of green urine color including the administration of further phenol groups containing drugs, methylene blue, pseudomonas urinary tract infections, or Hartnup disease were also considered [6, 7]. Pink-cloudy urine syndrome has been associated with excessive body weight [8]. For this analysis, the term excessive body weight was employed to denote subjects presenting with a body mass index of 25.0 kg/m^2 or more (or described in the article as overweight, adipose, or obese). Acute kidney injury was defined according to the KDIGO recommendations, which consider urine volume and creatinine [9]. One author entered the data into a pilot-tested spreadsheet, and the remaining author checked the entries.

Completeness of Reporting – Analysis

The completeness of each included case was graded as satisfactory, good, or excellent, as previously described [10, 11]. Basically, description completeness was evaluated according to following 5 components: (1) description of patient characteristics; (2) time pattern of propofol administration; (3) characteristics and duration of urine discoloration; (4) discontinuation and follow-up; and (5) laboratory characteristics. Each component was rated as 0, 1, or 2 and the reporting quality was graded according to the sum as satisfactory (<6), good (≥6), or excellent (>8).

Table 1. Characteristics of 95 patients with urinary or non-urinary green discoloration or pink-cloudy urine discoloration associated with the administration of propofol

	Green discoloration		Pink-cloudy urine discoloration	*p* value
	urinary	non-urinary		
Patients, *N*	54	9	32	
Female:male ratio	0.38	1.25	0.50	0.117
Age				
Years	50 [30–65]	37 [25–46]	27 [21–52]	0.1985
≤18 years, *N* (%)	7 (13)	1 (11)	5 (16)	0.7354

Data are presented as frequency (with percentage) or as median and interquartile range.

Pairwise deletion was used to deal with missing data. Categorical variables are presented as counts and were analyzed using the Fisher's exact test. Continuous variables are depicted as medians and interquartile ranges and were compared using the Kruskal-Wallis test with the post hoc Dunn-Bonferroni procedure. Statistical significance was defined by two-sided p values of <0.05.

As a final step, a consensus development conference among authors was held to summarize and compare green versus pink-cloudy urine discoloration regarding its frequency, time pattern, risk of acute kidney injury, and management. The frequency or probability was graded on a six-point Likert scale (never, very rarely, rarely, occasionally, very frequently, always).

Results

Search Outputs – Completeness of Reporting

The study flowchart is presented in Figure 1. For the final analysis, we retained 77 original reports [2, 3, 12–86] published since 1987: 30 from Asia, 27 from Europe, 17 from America, two from Oceania and one from Africa. Sixty-seven articles were published in English, six in Spanish, two in Dutch, one in Korean, and one in Turkish. The mentioned publications documented 95 cases of propofol-associated discoloration (and no case of fospropofol-associated discoloration): 54 (57%) with a green urine discoloration [2, 12–59], 32 (34%) with a pink-cloudy urine discoloration [3, 60–78], and nine (9.5%) with a non-urinary green discoloration [46, 79–86]. Completeness of reporting was satisfactory in 33 (35%), good in 35 (37%), and excellent in 27 (28%) cases.

Patients Characteristics

The 95 patients were 1.2–83 (median of 39) years of age, with a female:male ratio of 0.50. Patients with green urine discoloration, pink-cloudy urine discoloration, and non-urinary discoloration did not significantly differ with respect to age and sex (Table 1).

Urine Discoloration

Green Urine Discoloration

A green urine discoloration [2, 12–59] was observed in 53 and a urine bag green discoloration [34] in 1 case. The duration of propofol administration before discoloration of urine ranged between ≤3 and ≥72 h (Table 2). Propofol-associated urine discoloration was usually observed during the administration of this agent or immediately thereafter. In 11 cases, the urine discoloration was recognized ≥3 h after discontinuing propofol. In most cases, the duration of urine discoloration was ≤24 h after stopping propofol.

The administration of propofol was stopped after onset of urinary green discoloration in 23 but was continued in 9 cases (this information was not available for the remaining cases). In a Marfan patient, no urine green discoloration was noticed after propofol for 6 h. However, some days later, after receiving propofol during 4 h for a second surgical procedure, a green urine discoloration was observed [43]. Of note, in a Korean man given propofol for approximately 100 h, the intensity of urine discoloration was dependent on the propofol infusion rate [26]. The green urine discoloration observed after the administration of propofol was never associated with worsening kidney function (Table 2).

Pink-Cloudy Urine Discoloration

A pink-cloudy urine discoloration was reported in 32 cases with a median age of 27 years [3, 60–78]. An excessive body weight, an acidic urine pH, and increased uric acid excretion were documented in many cases (Table 3). Propofol-associated pink-cloudy urine discoloration occurred in patients given propofol for 24 h or less. The administration of propofol was stopped in all cases. Furthermore, parenteral fluid hydration was applied in many cases (N = 12). In most cases, the duration of pink-cloudy urine discoloration was 3 h or less after stopping propofol. A stage I acute kidney injury was observed in 2 cases [68, 74].

Table 2. Characteristics of 54 patients with green urine discoloration associated with the administration of propofol

	All	Without latency	With latency	Latency unknown	*p* value
Patients, *N*	54	33	11*	10	
Age					
Years	50 [30–65]	45 [28–66]	52 [30–59]	48 [33–64]	0.7814
≤18 years	7	6	0	1	0.312
Concurrent causes of green discoloration, *N*	2	0	2[a]	0	
Duration of propofol administration before discoloration, *N*					0.0071
<0.5 h	6	3	2	1	
0.5–3 h	7	3	4	0	
4–24 h	9	6	3	0	
25–71 h	12	11	0	1	
≥72 h	9	9	0	0	
Information not available	11	1	2	8	
Urine bag discoloration syndrome	1	1	0	0	
Duration of discoloration after discontinuing propofol,[b] *N*					0.7277
≤3 h	7	6	1	0	
4–24 h	13	11	1	1	
25–71 h	11	4	4	3	
≥72 h	4	3	1	0	
Information not available	19	9	4	6	
Acute kidney injury, *N*	0	0	0	0	

Data are presented as frequency (with percentage) or as median and interquartile range. *3–6 h, *N* = 6; ≥7 h, *N* = 5. [a]Methylene blue [17], *N* = 1; methylene blue and metoclopramide [18], *N* = 1. [b]The administration of propofol was continued for ≤2 h (*N* = 2), 24–64 h (*N* = 6), and approximately 300 h (*N* = 1) in 9 cases [2, 13, 19, 25, 26, 29, 30, 40, 44]. The tenth case is presented in the body of the manuscript [29].

Non-Urinary Green Discoloration

A non-urinary green discoloration was observed in 9 subjects, 1.8–60 (median 37) years of age: green hair [49, 79, 83, 85] in four, green breast milk in three [82, 84, 85], and green liver [80] or stool [81] in each 1 case. A green urine discoloration preceded the non-urinary discoloration in only 1 case [49]. The duration of propofol administration was less than 5 min in one, 90 min in one, and 7 days in a further case (this information was not available for the remaining cases).

Reasoned Summary of the Results

Relative frequency, time pattern, possible harms for kidney function, management, and risk factors of green or pink-cloudy urine discoloration induced by propofol are summarized in Table 4.

Discussion

The normal urine color results from the pigment urochrome and varies from light yellow to deep amber or dark yellow [6, 7]. An abnormal urine discoloration can be alarming to both patients and healthcare professionals [6, 7]. The present systematic literature review delivers three main results. First, green urine discoloration mostly develops upon propofol administration for ≥24 h, rapidly subsides after discontinuation, and has never been associated with kidney injury. Second, pink-cloudy urine discoloration typically ensues with propofol administration for ≤24 h and is rarely associated with a mild acute kidney injury. Third, non-urinary green discoloration has rarely been reported.

Propofol-associated green urine discoloration, first observed in 1987 [1], results from a non-toxic phenolic chromophore, which is conjugated in the liver and eliminated in the urine [1]. Other medicines that contain phenol groups have been associated with green urine, including amitriptyline, flupirtine, flutamide, indomethacin, metoclopramide, mitoxantrone, promethazine, thymol, and the parenteral formulation of cimetidine [7]. Methylene blue is a further cause of green urine [7]. Blue urine is uncommon with methylene blue because it combines with urochrome to create a green color [7]. Finally, Hartnup disease and urinary tract infections caused by Pseudomonas species [7] and some traditional Persian medicines [87] have

Table 3. Characteristics of 32 patients with pink or cloudy urine discoloration associated with the administration of propofol

Age, years	27 [21–52]
Urine color, *N*	
Pink	23
Cloudy	9
Excessive body weight, *N*	9
Urine pH ≤6.0, *N*	10
Increased uric acid excretion, *N*	13
Duration of propofol administration, *N*	
≤3 h	4
4–24 h	4
≥25 h	0
Information not given	24
Duration of urinary discoloration, *N*	
≤3 h	13
4–24 h	3
≥25 h	0
Information not given	16
Onset of discoloration ≥3 h after discontinuing propofol, *N*	2
Stage I acute kidney injury, *N*	2

Data are presented as frequency (with percentage) or as median and interquartile range.

Table 4. Relative frequency, time pattern, possible harms to kidney function, management, and risk factors of green or pink-cloudy urine discoloration induced by propofol

	Urine discoloration	
	green	pink-cloudy
Relative frequency	Occasionally	Rarely
Time pattern		
Duration of administration		
≤3 h	Occasionally	Very frequently
4–24 h	Occasionally	Very frequently
≥25 h	Very frequently	Never
Time interval[a]		
Without latency	Very frequently	Very frequently
With latency	Rarely	Very rarely
Discoloration[b] for ≤24 h	Very frequently	Very frequently
Excessive body weight*	Never	Occasionally
Acute kidney injury	Never	Rarely
Management	Unnecessary	Recommended

Following six-point Likert scale was used: always, very frequently, occasionally, rarely, very rarely, never. [a]Onset of discoloration ≥3 h after discontinuing propofol. [b]After discontinuing propofol. *Risk factor.

also been linked with this phenomenon. This review indicates that the green urine discoloration induced by propofol may occur from a few hours to a few days after its administration. The results also point out that the urine discoloration sometimes occurs more than 3 h after propofol is withheld and may persist for a few days after discontinuing it. Finally, the results indicate that there is no harm for the kidneys.

Generally, the association between propofol and pink-cloudy urine discoloration is less recognized than that with green discoloration. Pink urine syndrome, also termed brick dust urine (or sedimentum lateritium), refers to pink urine or pink urine sediment that occurs in the presence of precipitated uric acid [8, 74, 88, 89]. The pink hue results from the attachment of uricine, a pigment originated from bilirubin, to uric acid at an acidic

urine pH. Following four factors predispose to this syndrome: hyperuricemia (for great amounts of uric acid to appear in the urine, a large pool is required to draw from); an elevated fractional excretion of uric acid; acidic urine (a sine qua non for precipitation of uric acid); and an increased uricine production (usually induced by conditions such as excessive body weight, fever, infections, stress, starvation, and acidosis). Pink urine syndrome is well recognized among apparently healthy newborn babies [8, 88] and in obese patients after surgery [8, 89]. The results of the present analysis demonstrate that propofol may predispose to pink urine syndrome. This likely arises from the fact that propofol increases uric acid excretion and activates uricine synthesis [1, 74]. Considering that acute kidney injury is a possible consequence of propofol-associated pink urine syndrome, discontinuation of this hypnotic, fluid loading to increase urine output, and urinary alkalinization to convert uric acid to the more soluble urate salt deserve consideration in these cases.

Interestingly, this review demonstrates that propofol may also result in green hair, breast milk, liver, or stool. Fospropofol is a water-soluble propofol prodrug designed to overcome the disadvantages caused by the lipid-based formulation of propofol. No cases of fospropofol-associated urine discoloration have so far been reported. Nonetheless, this effect is expected given the need for the prodrug to convert to propofol [90].

The principal limitation of this review arises from the small number of published cases and the inherent risk of publication bias. Moreover, our analysis does not allow the establishment of the prevalence of urine discoloration caused by propofol. Furthermore, completeness of reporting cases was variable. Consequently, unfortunately, we were not able to provide data on underlying diagnosis, performed procedures, liver and kidney functions, or co-administered drugs. Finally, the suggested therapeutic approach is derived from pathophysiological considerations. In addition to the comprehensive literature search, which included three databases, this analysis has the strength of describing the time pattern of propofol-induced urine discoloration. Further, besides the rather known urine green tint, it also describes a pink-cloudy urine stain and the green discoloration of hair, liver, milk, or stool. This review analyzes the available information on the association between propofol and the occurrence of a pink-cloudy and green urine discoloration (Table 4).

In conclusion, green urine discoloration mostly develops upon propofol administration for ≥24 h, rapidly subsides after discontinuation, and has never been associated with kidney damage. Pink-cloudy urine discoloration typically ensues with propofol administration for ≤24 h and has rarely been associated with a mild acute kidney injury. Non-urinary green discoloration has rarely been reported.

Statement of Ethics

An ethics statement is not applicable because this study is based exclusively on published literature.

Conflict of Interest Statement

Sebastiano A.G. Lava is the current recipient of research grants from Fonds de perfectionnement, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland; Fondation SICPA, Prilly, Switzerland; Fondazione Dr. Ettore Balli, Bellinzona, Switzerland; Fondazione per il bambino malato della Svizzera italiana, Bellinzona, Switzerland; and Frieda Locher-Hofmann Stiftung, Zürich, Switzerland.

Funding Sources

The study was partially supported by the Italian Ministry of Health (Ricerca Corrente 2021).

Author Contributions

Dr. Mario G. Bianchetti and Dr. Sebastiano A.G. Lava conceived the study design. Dr. Ana Lasica, Dr. Pietro Camozzi, and Dr. Mario G. Bianchetti wrote the draft of the manuscript. Dr. Ana Lasica, Dr. Cinzia Cortesi, and Dr. Mario G. Bianchetti conducted the literature search and performed article selection, data extraction and analysis, and reporting quality. Dr. Pietro Camozzi, Dr. Gregorio P. Milani, and Dr. Sebastiano A.G. Lava supervised data analysis. Dr. Federica M. Schera, Dr. Gregorio P. Milani, and Dr. Sebastiano A.G. Lava corrected the draft of the manuscript. All authors contributed to revising the manuscript and approved the final version.

Data Availability Statement

All data generated or analyzed during this study are included in this article and its references. Further inquiries can be directed to the corresponding author.

References

1 Vanlersberghe C, Camu F. Propofol. Handb Exp Pharmacol. 2008;182:227–52.
2 Bodenham A, Culank LS, Park GR. Propofol infusion and green urine. Lancet. 1987; 2(8561):740.
3 Nates J, Avidan A, Gozal Y, Gertel M. Appearance of white urine during propofol anesthesia. Anesth Analg. 1995;81(1):210.
4 Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann T, Mulrow CD, et al. Mapping of reporting guidance for systematic reviews and meta-analyses generated a comprehensive item bank for future reporting guidelines. J Clin Epidemiol. 2020;118:60–8.
5 Aromataris E, Munn Z, editors. JBI manual for evidence synthesis. JBI; 2020.
6 Aycock RD, Kass DA. Abnormal urine color. South Med J. 2012;105(1):43–7.
7 Raymond JR, Yarger WE. Abnormal urine color: differential diagnosis. South Med J. 1988;81(7):837–41.
8 Deitel M, Thompson DA, Saldanha CF, Ramshaw PJ, Patterson MC, Pritzker KP. "Pink urine" in morbidly obese patients following gastric partitioning. Can Med Assoc J. 1984;130(8):1007–11.
9 Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO clinical practice guideline for acute kidney injury. Kidney Int Suppl. 2012;2: 1–138.
10 Vismara SA, Lava SAG, Kottanattu L, Simonetti GD, Zgraggen L, Clericetti CM, et al. Lipschütz's acute vulvar ulcer: a systematic review. Eur J Pediatr. 2020; 179(10):1559–67.
11 Murad MH, Sultan S, Haffar S, Bazerbachi F. Methodological quality and synthesis of case series and case reports. BMJ Evid Based Med. 2018;23(2):60–3.
12 Hughes KR, Armstrong RF. Continuous infusion of propofol. Anaesthesia. 1988; 43(4):331.
13 Ananthanarayan C, Fisher JA. Why was the urine green? Can J Anaesth. 1995;42(1):87–8.
14 Tirosh R, Barzilay Z, Almog S, Paret G. Propofol and green urine. Paediatr Anaesth. 1996;6(3):244.
15 Blakey SA, Hixson-Wallace JA. Clinical significance of rare and benign side effects: propofol and green urine. Pharmacotherapy. 2000;20(9):1120–2.
16 Lepenies J, Toubekis E, Frei U, Schindler R. Green urine after motorcycle accident. Nephrol Dial Transplant. 2000;15(5):725–6.
17 Bernante P, Francini F, Zangrandi F, Menegon P, Toniato A, Feltracco P, et al. Green urine after intragastric balloon placement for the treatment of morbid obesity. Obes Surg. 2003;13(6):951–3.
18 Gillett MJ, Burnett JR. Medications and green urine. Intern Med J. 2006;36(1):64–6.
19 Tønseth KA, Tindholdt TT, Hokland BM, Abyholm FE. Green urine after surgical treatment of pressure ulcer. Scand J Plast Reconstr Surg Hand Surg. 2007;41(1):39–41.
20 Tan CK, Lai CC, Cheng KC. Propofol-related green urine. Kidney Int. 2008;74(7):978.
21 Batllori Gastón M, Rivero Marcotegui A, Castañeda Pascual M, Murillo Jaso E. Coloración verde de la orina relacionada con infusión de propofol [Green urine related to infusion of propofol]. Rev Esp Anestesiol Reanim. 2009;56(5):334.
22 Leclercq P, Loly C, Delanaye P, Garweg C, Lambermont B. Green urine. Lancet. 2009; 373(9673):1462.
23 Lee YC, Lee JN, Bae JS, Park YC. Green urine in a patient who received a continuous infusion of propofol: a case report. Korean J Anesthesiol. 2009;56(3):325–7.
24 Rivero A, Muñoz R, Moreno M. What is your guess? Clin Chem. 2009;55(8):1600.
25 Gupta D, Gupta R. Green urine. Sci World J. 2011;11:1101–2.
26 Ku BD, Park KC, Yoon SS. Dark green discoloration of the urine after prolonged propofol infusion: a case report. J Clin Pharm Ther. 2011;36(6):734–6.
27 Shioya N, Ishibe Y, Shibata S, Makabe H, Kan S, Matsumoto N, et al. Green urine discoloration due to propofol infusion: a case report. Case Rep Emerg Med. 2011;2011: 242514.
28 Barbara DW, Whalen FX Jr. Propofol induction resulting in green urine discoloration. Anesthesiology. 2012;116(4):924.
29 Torka P, Sharma R. Green coloured urine. Neth J Med. 2012;70(6):282–5.
30 Fernández S, Castro P, Nogué S, Nicolás JM. Orina verde secundaria a propofol [Green urine due to propofol]. Med Clin. 2013; 141(10):463.
31 Lee JS, Jang HS, Park BJ. Green discoloration of urine after propofol infusion. Korean J Anesthesiol. 2013;65(2):177–9.
32 Lee MJ, Lee HJ, Kim JM, Koh SO, Kim EH, Na S. Green urine after propofol infusion in the intensive care unit. Korean J Crit Care Med. 2014;29(4):328–30.
33 Regensburger M, Huttner HB, Doerfler A, Schwab S, Staykov D. Propofol-related urine discoloration in a patient with fatal atypical intracerebral hemorrhage treated with hypothermia. Springerplus. 2014;3:551.
34 Kuiper MA. Green urine. Neth J Crit Care. 2015;19:30.
35 Pedersen AB, Kobborg TK, Larsen JR. Grass-green urine from propofol infusion. Acta Anaesthesiol Scand. 2015;59(2):265–7.
36 Rawal G, Garg N, Wani UR, Yadav S. Green urine: a rare benign side effect of propofol. Int J Med Res Rev. 2015;3(1):136–8.
37 Rawal G, Yadav S. Green urine due to propofol: a case report with review of literature. J Clin Diagn Res. 2015;9(11):OD03–4.
38 Sigdel S. Propofol induced green urine. Anesth Clin Res. 2015;6(7):1000542.
39 Urushidani S, Kuriyama A. Green urine. QJM. 2015;108(8):675.
40 Fujii-Abe K, Kawahara H, Fukayama H. An analysis of green discoloration of urine caused by propofol infusion. J Clin Anesth. 2016;35:358–60.
41 Urraca-Espeje C, Portero-Portaz JJ, Córdoba-Soriano JG. Green urine due to propofol infusion. Med Intensiva. 2016;40(8):524.
42 van Rosmalen J, van Oers JA. Een man met groene urine na een val van de trap [A young man with green urine]. Ned Tijdschr Geneeskd. 2016;160:D585.
43 Kim GE, Kim DY, Yoo DK, Lee JH, Lee SM, Min JJ. Green urine after general anesthesia with propofol: different responses in the same patient–a case report. Anesth Pain Med. 2017;12(1):32–6.
44 Bredehoeft CT, Rist RT, ChristianRojas-Moreno ACA. Green urine from propofol. Am J Hosp Med. 2018;2(4):2018–24.
45 Choudhury P, Mohapatra A, Sanghi S. Common anaesthetic agent causing an uncommon side effect. BMJ Case Rep. 2018 Jun 10;2018:bcr2018225126.
46 Demir T, Aslan K, Balal M, Bicakci S, Bozdemir H. Green urine appearance in a patient with refractory status epilepticus due to propofol infusion. J Clin Anal Med. 2018;9: 150–2.
47 Lee DE, Chung K, Cho JY, Lee JJ, Park HR, Song P. Propofol-induced green urine in a patient with refractory status epilepticus. J Epilepsy Res. 2018;8(2):97–9.
48 Corzo-Gilabert R, Domínguez-Fuentes MB, Viejo-Almanzor A, García-Gil D. Orina verde después de una rectosigmoidoscopia [Green urine after a rectosigmoidoscopy]. Emergencias. 2019;31(4):291.
49 Arlabán Carpintero L, Hidalgo Sanz J, Pinilla Borobia J, Palanca Arias D. Propofol: from white to green. An Pediatr. 2020;93(5):347–8.
50 Boshkovska Spaseski M, Spaseski D. Green urine. N Engl J Med. 2020;383(23):e128.
51 Greenstein AM, Heaton D. Bizarre bleeps: a case report of propofol induced urine discoloration following a single dose. Eur J Med Case Rep. 2020;4(9):305–7.
52 Miniksar ÖH, Yücel A, Aydoğan MS, Kaya F, Togal T. Propofol Infüzyonu Sonrası Idrarın Yeşil Renk Değişikliği: Bir Olgu Sunumu [Green discoloration of urine after propofol infusion: a case report]. J Cardiovasc Thorac Anaesth Intensive Care Soc. 2020;26:267–71.
53 Balıkoğlu E, Arıkanoğlu A, Tüzen AS, et al. Yoğun Bakımda Hastamın İdrarı Niçin Yeşil Oldu? [Why my patient's urine was green in intensive care unit?] J Cardiovasc Thorac Anaesth Intensive Care Soc. 2021;27:177–9.
54 Çelik M, Çelik MC, Sibek T. Green urine: a rare side effect of propofol in a pediatric case. Am J Clin Case Rep. 2021;2:1046.
55 Clarke J. Cataracts, propofol and green urine. Ophthalmic Anaesth. 2021;11:62.

56 Martínez-Ávila MC, Rodriguez Yanez T, Borré-Naranjo D, Almanza A, Dueñas Castell C. ¿Es la bolsa o la orina lo que cambió de color? Diagnóstico diferencial y relevancia clínica [It is the urine bag, or the urine discolored? Differential diagnosis and clinicalrelevance]. Med Clín Práct. 2021;4:100274.
57 Abuabara-Franco E, Narvaez-Angulo M, Lara-Pineda J, et al. Orina verde asociada al uso de propofol. A propósito de un caso [Green urine associated with the use of propofol. About a case]. Arch Med. 2022;18:1525.
58 Kuriyama A. Green urine due to propofol. Postgrad Med J. 2022;98(1157):230.
59 Pacheco de Vasconcelos SR, Alcántara Montero A, Fernández Bermejo M. Green discoloration of the urine following sedation with propofol for colonoscopy. Rev Esp Enferm Dig. 2023;115(7):393–4. Epub ahead of print.
60 Masuda A, Hirota K, Satone T, Ito Y. Pink urine during propofol anesthesia. Anesth Analg. 1996;83(3):666–7.
61 Kato N, Ogawa R. Does use of propofol in heavy alcohol drinkers tend to discolor their urine? Acta Anaesthesiol Scand. 1999;43(8):868–9.
62 Stern AB, Stewart HD, Singh HK, Kshirsagar AV. Pink urine after propofol anesthesia. Kidney Int. 2010;78(11):1193.
63 Punj J, Anand R, Darlong V, Pandey R. Milky urine! A cause for concern? Indian J Anaesth. 2013;57(1):87–8.
64 Mills F, Jeffery J, Ayling R. A cause of pink urine. BMJ. 2013;347:f6289.
65 Ong YY, Thong SY, Ng SY. Cloudy urine after propofol anesthesia; a rare occurrence after a routine anesthetic. J Anesth Clin Res. 2014;5:432.
66 Sinnollareddy M, Marotti SB. Propofol-associated urine discolouration in critically ill patients: case reports. Anaesth Intensive Care. 2014;42(2):268–9.
67 Verhoeven E, Capron A, Hantson P. Pink urine. Clin Toxicol. 2014;52(9):980–1.
68 Thamcharoen N, Leeaphorn N, Sanguankeo A. A pretty clue in pink: pink urine in a morbidly obese patient with lymphoma. Clin Nephrol. 2015;84(2):116–7.
69 Hou JD, Peng CZ. Pink urine following propofol anesthesia. Int J Gerontol. 2016;10(4):245.
70 Cheng IL, Chuang TJ, Lin WT. Pink urine after propofol infusion. Resusc Intensive Care Med. 2017;4:213–5.
71 Del Carpio-Orantes L, Elizalde-Bernal RJJ, Villegas-Dominguez JE, Morales-Ocon JE, Tejero-Da Silveira RK. Pink urine syndrome. Australas Med J. 2017;10:199–201.
72 Hwang BY, Kwon JY, Kim HK, Kim E, Hong S, Hong JM. Cloudy urine developed during total intravenous anesthesia with 2% propofol in the patient taking hydroxyurea: a case report. Anesth Pain Med. 2017;12(3):230–2.
73 Josephus Jitta N, Veneman SE, Maatman R, Aan de Stegge WB, Veneman TF. Urine changing from clear to milky-white. Neth J Med. 2018;76(8):379–80.
74 Tucker BM, Perazella MA. Pink urine syndrome: a combination of insulin resistance and propofol. Kidney Int Rep. 2019;4(1):30–9.
75 Ababou M, Boubekri A, Kartite N, Houba A, Doghmi N, Bakkali H. Pink urine syndrome (PUS): a case report. PAMJ Clin Med. 2020;3(35).
76 Baumgarten A, Newton M. Propofol-induced uric acid crystals: a case of cloudy urine. Paediatr Anaesth. 2021;31(10):1132–3.
77 Timbergen MJM, Samuels M. Een man met roze urine [A man with pink urine]. Ned Tijdschr Geneeskd. 2021;165:D5904.
78 Zhang F, Zhu X, Zhang H, Xu L, Wu W, Hu X, et al. Case report: pink urine syndrome following exposure to propofol: a rare, impressive but benign complication. Front Pharmacol. 2021;12:686619.
79 Callander CC, Thomas JS, Evans CJ. Propofol and the colour green. Anaesthesia. 1989;44(1):82.
80 Motsch J, Schmidt H, Bach A, Böttiger BW, Böhrer H. Long-term sedation with propofol and green discolouration of the liver. Eur J Anaesthesiol. 1994;11(6):499–502.
81 O'Regan AW, Joyce-Brady M. "Pond poop" from propofol. Intensive Care Med. 2003;29(11):2106.
82 Birkholz T, Eckardt G, Renner S, Irouschek A, Schmidt J. Green breast milk after propofol administration. Anesthesiology. 2009;111(5):1168–9.
83 Ricci F, Lunghi F, De Simone C, Peris K. Propofol-induced irreversible hair depigmentation: a case report. Int J Dermatol. 2017;56(6):676–8.
84 Rainone A, Delucilla L, Elofer S, Bensimon L, Abittan G. Propofol-induced green breast milk: a case report. Can J Hosp Pharm. 2019;71(6):389–91.
85 Pulos BP, Sviggum HP, Sharpe EE. Propofol-associated green hair discoloration. Anesthesiology. 2019;130(3):445.
86 Bulut O, Ovali F. Green breast milk: a rare side effect of propofol. J Paediatr Child Health. 2021;57(1):153–4.
87 Kolouri S, Daneshfard B, Jaladat AM, Tafazoli V. Green urine in traditional Persian medicine: differential diagnosis and clinical relevance. J Evid Based Complementary Altern Med. 2017;22(2):232–6.
88 Küpeli S, Yurdakök M, Kilinc G, Bilgetekin E. Urinary uric acid levels and discoloration of diapers in healthy neonates. Pediatr Nephrol. 2005;20(9):1361–2.
89 Ogawa S, Takiguchi J, Nako K, Okamura M, Sakamoto T, Kabayama S, et al. Elucidation of the etiology and characteristics of pink urine in young healthy subjects. Clin Exp Nephrol. 2015;19(5):822–9.
90 Fechner J, Ihmsen H, Jeleazcov C, Schüttler J. Fospropofol disodium, a water-soluble prodrug of the intravenous anesthetic propofol (2,6-diisopropylphenol). Expert Opin Investig Drugs. 2009;18(10):1565–71.